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HOLOTHURIANS (ECHINODERMATA: HOLOTHUROIDEA)

By

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ABSTRACT

A total of 213 holothurians, representing 16 species, was collected during Project Hourglass, a 28-month systematic survey of ten stations along two transects (6-73 m) off central western Florida. This material, supplemented with 81 additional Gulf of Mexico specimens supplied by the Florida Department of Natural Resources, brings the total number of species reported in this paper to 20. Of these species, 19 have previously been reported from the Gulf of Mexico. One, *Allothyone mexicana*, can be considered endemic to the Gulf of Mexico, and another, *Thyone crassidisca*, was recently described from material including Hourglass specimens. Systematic accounts, pertinent ecological data and line drawings of taxonomically important skeletal elements are included for each species. Keys to all 60 holothurian species known from the Gulf of Mexico are provided. Range extensions for several species are noted.

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INTRODUCTION

Holothurians, commonly known as sea cucumbers, are a common component of the benthic invertebrate fauna throughout the marine environment. Often considered lifeless and unappealing creatures, they are frequently overlooked. Though members of the phylum Echinodermata, holothurians differ dramatically from their relatives the sea urchins, sea stars, brittle stars and sea lilies. A secondary bilateral symmetry often replaces the "5-sided" pentamerous symmetry commonly found in other echinoderms. The skeleton is drastically reduced to microscopic ossicles, thereby providing many members of the group with the ability to distort their body form. Certain species of sea cucumbers (especially those of the order Aspidochirotida) are economically important as a food source. Throughout the Orient, many species are dried and served as a delicacy known as trepang or bêche-de-mer.

Although numerous papers have been published on Caribbean holothurians (H. L. Clark, 1919, 1933; Deichmann, 1926, 1930, 1940, 1963; Engel, 1939; Fontaine, 1953; Domantay, 1959; Levin and Gomes, 1975; Pawson, 1976; and others), few investigators have restricted their studies to the Gulf of Mexico. Of these, the majority have limited their investigations to one portion of the Gulf, defined here as that body of water north of a line connecting the Florida Keys, the northwestern tip of Cuba, and the Yucatan Peninsula. The earliest explorers of the holothurian fauna were Théel (1886b), reporting on deep water forms collected during the Blake Expedition, and Ives (1890), working off Veracruz and the nothern Yucatan coast. Following these reports, studies on the Gulf of Mexico holothurians lapsed for more than 50 years. Deichmann (1954) recorded 67 species from the Gulf of Mexico, although some are known only from waters adjacent to the Gulf. Caso (1955) reported on six littoral species from the east coast of Mexico and later (Caso, 1961) added three additional species to her faunal list. Harry (1979) summarized the findings of several workers of the northwestern Gulf and listed 18 species from that area. A review of the literature and examination of the holothurians collected by the Florida Department of Natural Resources (FDNR) during Project Hourglass (Figure 1) and subsequent programs revealed a total of 60 holothurian species currently known to occur in the Gulf of Mexico.

ACKNOWLEDGMENTS

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METHODS AND MATERIALS

Sampling procedures during Project Hourglass consisted of nighttime collections for 28 consecutive months at benthic Stations A-E (northern transect) and Stations I-M (southern transect). For the purpose of collecting comparative diurnal material, post-cruise sampling at Stations B, C and D was conducted during daytime. Pertinent station data are listed in Table 1.

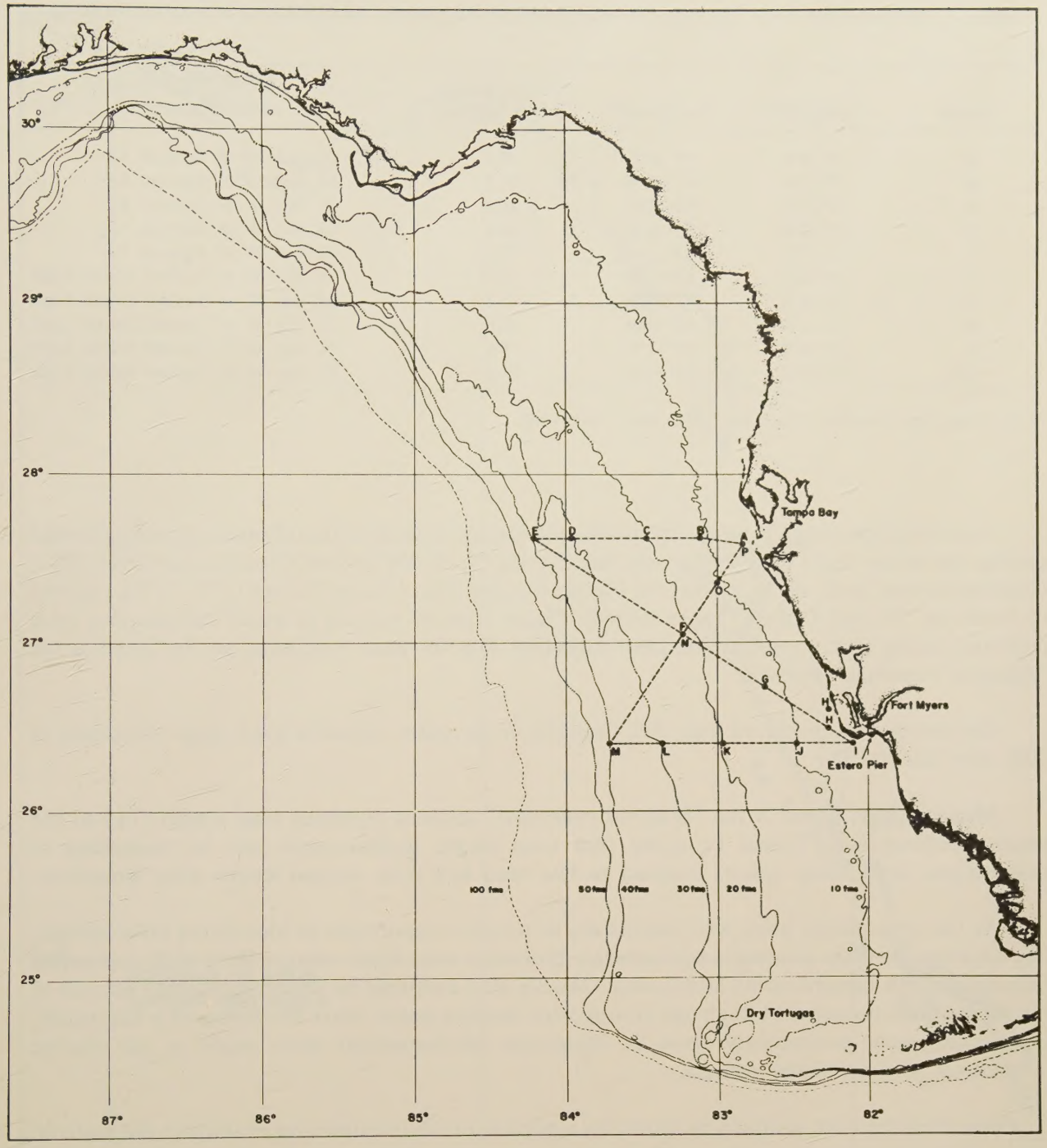

Figure 1. Hourglass cruise pattern and station locations.

Each site was sampled using both a box-type dredge and a trynet. The dredge, 91 cm wide × 33 cm high × 74 cm deep and lined with 1.9 × 3.8 cm expanded steel mesh, was towed at approximately 2 kn for 15 min. The 6.1 m flat or ballon type trynets were constructed of 5.1 cm mesh and towed at approximately 2 kn for 30 min. A description of the project and further information on sampling procedures can be found in Joyce and Williams (1969).

TABLE 1. LOCATIONS AND DEPTHS OF HOURGLASS STATIONS PRODUCING HOLOTHUROIDEA.

Station	Latitude*	Longitude*	Established Depth (meters)	Approximate Nautical Miles Offshore*
A	27°35′N	82°50′W	6.1	4, due W of Egmont Key
B	27°37′N	83°07′W	18.3	19, due W of Egmont Key
C	27°37′N	83°28′W	36.6	38, due W of Egmont Key
D	27°37′N	83°58′W	54.9	65, due W of Egmont Key
E	27°37′N	84°13′W	73.2	78, due W of Egmont Key
I	26°24′N	82°06′W	6.1	4, due W of Sanibel Island Light
J	26°24′N	82°28′W	18.3	24, due W of Sanibel Island Light
K	26°24′N	82°58′W	36.6	51, due W of Sanibel Island Light
L	26°24′N	83°22′W	54.9	73, due W of Sanibel Island Light
M	26°24′N	83°43′W	73.2	92, due W of Sanibel Island Light

*U.S. Coast and Geodetic Chart No. 1003, dated June 1966.

Additional specimens supplied by the Florida Department of Natural Resources were collected during one of two more recent programs, the Florida PL 88-309 Federal Clam Project (1969-1971) (Godcharles and Jaap, 1973a, b), and the Florida Shrimp Fleet Discard Survey (1977-1978), referred to herein as "Shrimp Discard" (unpublished). Figure 2 shows stations at which holothurians were collected during these projects. Complete collection data for these specimens can be found in the "*Material examined*" sections.

Specimens were preserved with 10% formalin in sea water, rinsed in fresh water and stored in 70% ethyl alcohol.

Measurements noted in the "*Material examined*" sections represent total length (TL) to the nearest millimeter. It should be noted that total length measurements can be misleading in holothurians since many species contract to less than half their normal length when preserved.

As the microscopic body wall ossicles are of primary importance in identifying holothurians, line drawings of these structures are included. Drawings were made using a Wild M20 compound microscope with camera lucida attachment. Ossicles were prepared by dissolving a small portion of the body wall in household bleach and rinsing with distilled water. After air-drying on a microslide, the ossicles were permanently fixed in Permount. Measurements were made to the nearest micrometer with an ocular reticule.

Gut contents were analysed by removing a portion of the intestine and examining the material with a Wild M8 stereoscope. Since many holothurians ingest large amounts of inorganic material, generalized categories have been used to describe gut contents. When no gut contents could be found, the diet section for that species account was deleted.

Collection Tables 4-10 are included within systematic accounts of those species which were encountered during more than five separate collections.

Specimens were photographed on a light table using a 35 mm camera with 50 mm macro lens. For some species, photographs of specimens collected from outside the study area have been substituted when suitable material was lacking.

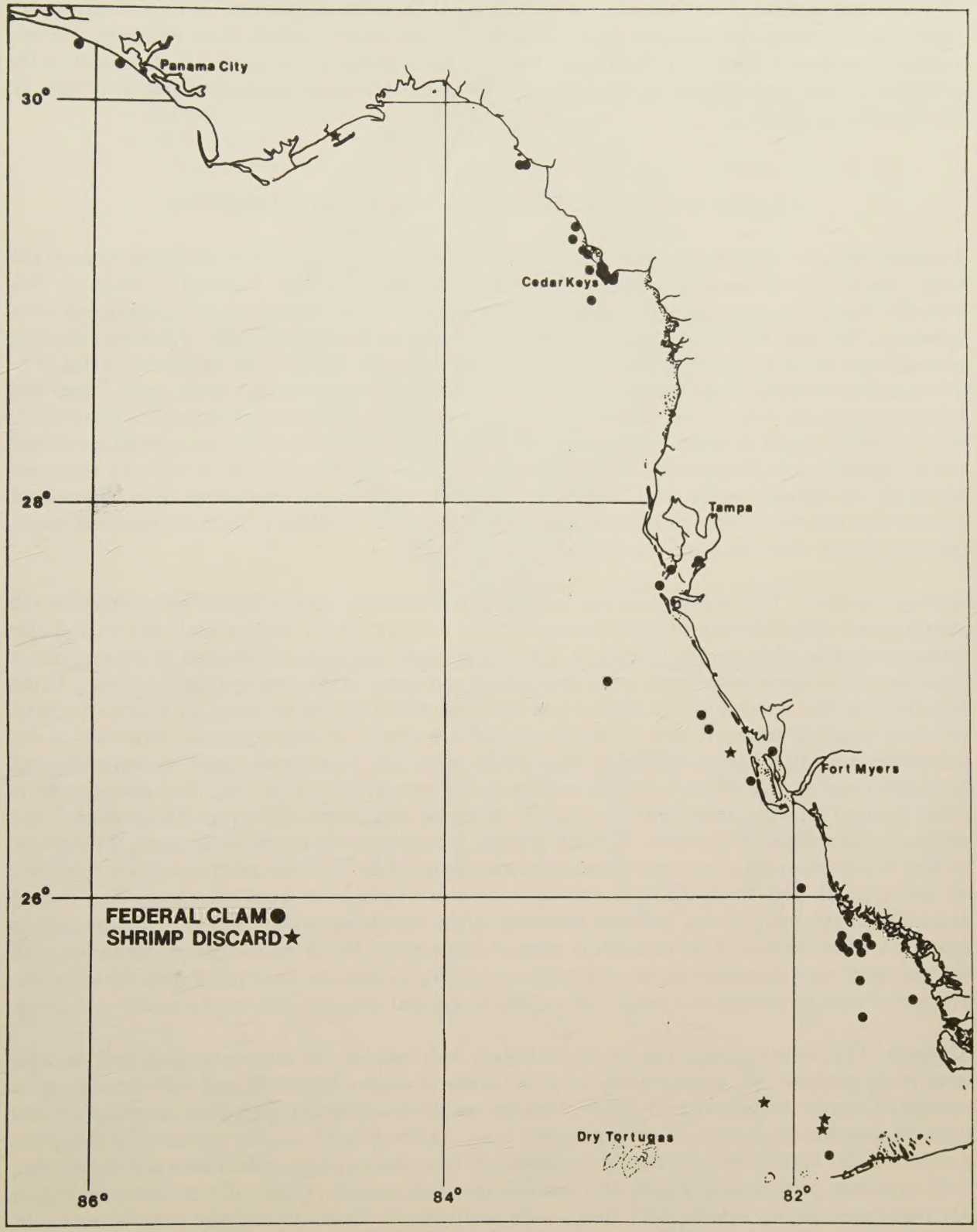

Figure 2. Station locations for Federal Clam and Shrimp Discard projects.

Selected specimens are deposited at the National Museum of Natural History, Smithsonian Institution (USNM), Washington, D.C., and the Indian River Coastal Zone Museum, Harbor Branch Foundation (IRCZM), Ft. Pierce, Florida. All remaining specimens are deposited in the collection of the Florida Department of Natural Resources Marine Research Laboratory (FSBC I), St. Petersburg, Florida.

TAXONOMIC CHARACTERS IN THE HOLOTHUROIDEA

External features: Holothurians are usually cylindrical, with mouth and anus at oposite ends of the body. Some are flattened dorsoventrally, with the ventral surface forming a more or less well-developed sole, and several species of the Dendrochirotida are U-shaped, with mouth and anus upturned. The body wall ranges from thick and firm to extremely thin and fragile. The water-vascular system is expressed externally by the tube feet and tentacles. The mouth is surrounded by a ring of 8-30 retractile tentacles; most commonly, 10 tentacles occur. They may be simple, with finger-like branches (digitate), with feather-like branches (pinnate), with a richly branching pattern (dendritic), or with shield-shaped extremities attached to the tentacle stem (peltate). Tube feet (podia) are absent in the Apodida and Molpadiida; in the other orders, they may be scattered in both the radii and interradii, or restricted to the radii, where they form five conspicuous longitudinal rows. Dorsal and ventral tube feet often differ; dorsal feet may be papilliform, or modified to form conspicuous warts, whereas ventral feet are usually suctorial.

Internal anatomy: The esophagus is surrounded by a calcareous ring (see below) which supports the pharynx and related structures and serves as a point of insertion for longitudinal muscles and also retractor muscles when present (Figure 3). The long stomach-intestine is supported by mesenteries; it describes one or more large loops in the body cavity and opens to the anus by way of a cloaca. In the Dendrochirotida, the pharyngeal region is an introvert which can be retracted by means of special retractor muscles; introvert and retractor muscles are absent in other groups. Posterior to the calcareous ring is the water-vascular ring which gives rise to a stone canal in the middorsal interradius and to one or more Polian vesicles on the ventral side of the ring. The madreporite is either internal or is in contact with the exterior by means of a pore-canal; in the Elasipodida, it lies on the dorsal surface of the body. In some groups, tubular tentacle ampullae lie along the exterior surface of the calcareous ring; each tentacle has a single ampulla. In all holothurians except members of the Apodida and Elasipodida, a pair of respiratory trees arise from the cloaca and extend anteriorly in the body cavity. In some members of the Aspidochirotida, tubular Cuvierian organs arise from near the base of the respiratory trees. A single gonad lies in the middorsal interradius, and the gonoduct runs anteriorly in the middorsal mesentery to open to the exterior near the tentacles. The gonad may be present as a single tuft or may be divided into two tufts by the dorsal mesentery.

Skeleton: The skeleton comprises the dermal body wall ossicles, the calcareous ring, and the anal teeth of *Actinopyga*. The ossicles assume a wide variety of shapes (Figure 4), and most are distinctive enough to enable identification of species. Ossicles are given convenient descriptive names, and some types of ossicles are typical of certain higher taxa. Tables (Figure 4A, B) consist of a flattened, perforated disc surmounted by a spire composed of two, three or four rods. Plates are usually flat, with numerous perforations (Figure 4E). Buttons are small, smooth (Figure 4C), or knobbed (Figure 4J) perforated plates, usually with four to six perforations. Rods are usually narrow, elongate, straight (Figure 4H), or curved (Figure 4D), with or without perforations. Baskets or cups are simply cup-shaped ossicles with a smooth or spinous rim and a concave perforated area (Figure 4I). Minute rosettes (Figure 4F) and "biscuit-shaped" ossicles (Figure 4G) are found in some species. The typical anchor (Figure 4K) of the Apodida is supported on an anchor plate (Figure 4L) and consists of

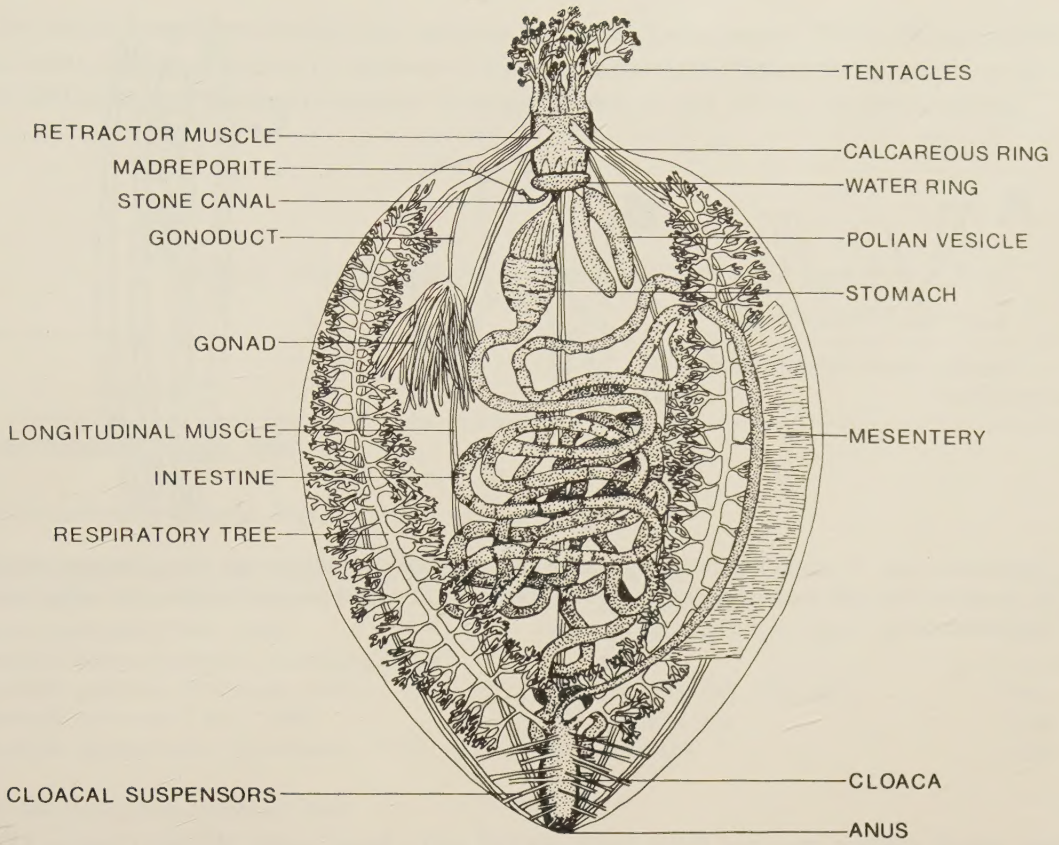

Figure 3. Anatomy of the holothurian, *Sclerodactyla briareus*, order Dendrochirotida (after Coe, 1912).

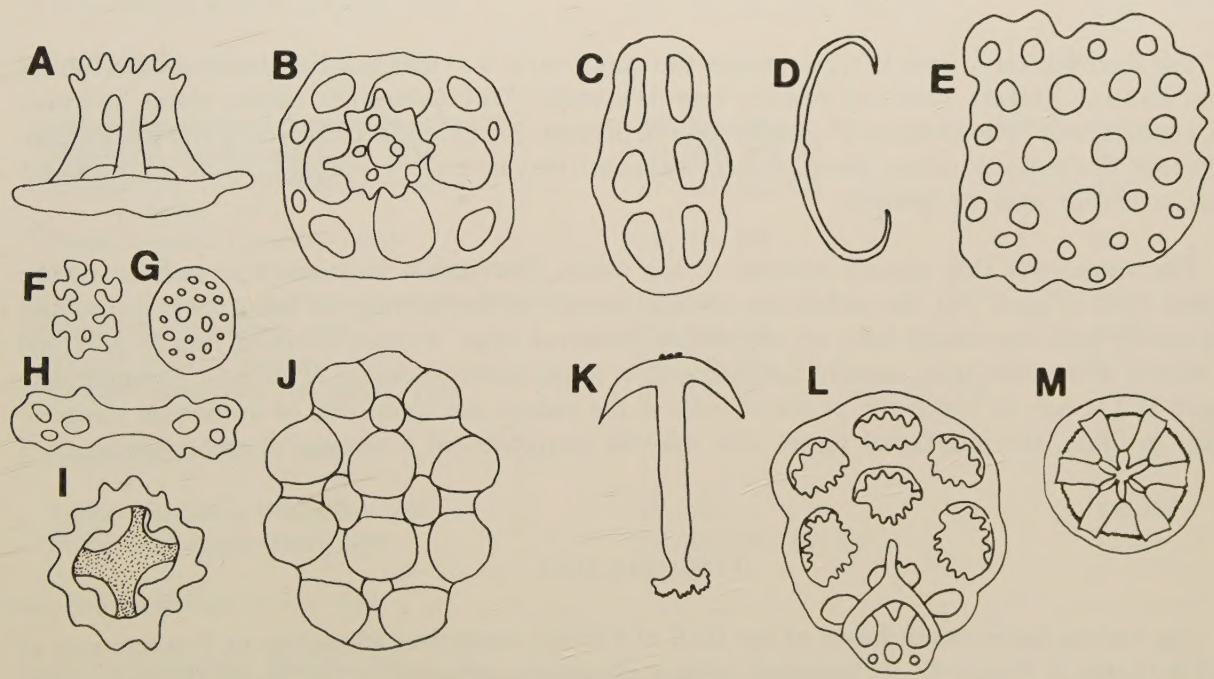

Figure 4. Characteristic holothurian skeletal ossicles. A. table, lateral view; B. table, dorsal view; C. smooth button; D. "C-shaped" ossicle; E. perforated plate; F. rosette; G. "Biscuit-shaped" ossicle; H. rod; I. basket; J. knobbed button; K. anchor; L. anchor plate; M. wheel.

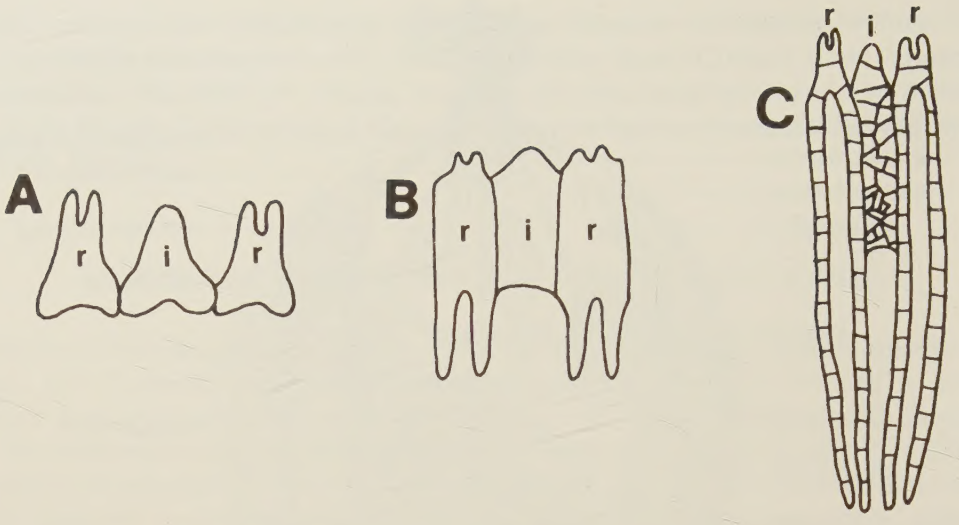

Figure 5. Calcareous rings. A. simple ring lacking posterior projections; B. simple ring with short posterior projections; C. complex ring with long posterior projections made up of numerous small pieces. r = radial piece; i = interradial piece.

curved arms, which may or may not carry teeth, a shaft and a basal stock. Wheels (Figure 4M) are usually symmetrical and display little variation within species. In some members of the Molpadiida, the calcareous ossicles become transformed into ovoid, wine-red, phosphatic deposits which are rich in iron.

The distribution of ossicle types among the major taxa is as follows: Dendrochirotida: tables, plates, buttons, baskets, rods and rosettes may be present. Aspidochirotida: tables, plates, buttons, rods, rosettes, and "biscuit-shaped" ossicles may be present. Elasipodida: plates, rods and wheels may be present. Molpadiida: tables, plates, rods and anchors may be present. Apodida: rods, anchors and plates or wheels may be present.

The calcareous ring usually consists of ten plates, five interradials and five radials. In the simplest form (Figure 5A), the radials are notched anteriorly for insertion of retractor muscles, and both radials and interradials have an undulating posterior edge. A more complex ring (Figure 5B) has radials with short tails, usually consisting of a single piece of calcite. The most complex ring (Figure 5C) is one in which the posterior tails of the radials are composed of numerous pieces of calcite; in these, the interradial pieces also may be composed of a mosaic of small pieces.

SYSTEMATICS

The known holothurian fauna of the Gulf of Mexico comprises 60 species in 5 orders and 13 families (Table 2; Figure 6). As expected, closest geographic affinities of this fauna are with faunas from the adjacent tropical waters of the Caribbean area. In the species accounts which follow, synonymies are restricted to the original reference to the species, all names under which the species has been cited, all references cited in the species accounts, and all known systematic references since

1930. For more complete synonymies prior to 1930, see Deichmann (1930). Many distributional records, name changes and new combinations have been extracted from a monograph on the shallow water holothurians of the northwestern Atlantic (Pawson and Miller, in preparation).

TABLE 2. HOLOTHUROIDEA FROM THE GULF OF MEXICO.

Species	Distribution in Northwest Atlantic Geographic[1]	Bathymetric (m)
Order Dendrochirotida Grube, 1840		
Family Cucumariidae Ludwig, 1894		
Duasmodactyla seguroensis (Deichmann, 1930)	EF, SG, CA	littoral
**Euthyonacta solida* (Deichmann, 1930)	EF, EG, NG, SG	6-124
+**Ocnus pygmaeus* (Théel, 1886)	EU, EF, EG, NG, SG, CA	0-37
Pseudocolochirus mysticus Deichmann, 1930	EU, SG	18-215
+**Thyonella gemmata* (Pourtalès, 1851)	EU, EF, EG, NG, WG, SG	0-6
+**Thyonella pervicax* (Théel, 1886)	EU, EF, EG, SG	6-40
+**Thyonella sabanillaensis* (Deichmann, 1930)	EG, WG, CA	4-30
Family Sclerodactylidae Panning, 1949		
Euthyonidiella destichada (Deichmann, 1930)	EF, SG	littoral
Euthyonidiella trita (Sluiter, 1910)	SG, CA	littoral
* *Pseudothyone belli* (Ludwig, 1886)	EF, EG, SG, CA	0-37
+ *Sclerodactyla briareus* (Lesueur, 1824)	EU, EF, EG, NG, WG, SG	0-24
Family Phyllophoridae Östergren, 1907		
+*Allothyone mexicana* (Deichmann, 1946)	EG, NG, WG	0-6
Pentamera pulcherrima Ayres, 1854	EU, WG, CA	0-27
**Phyllophorus* (*Urodemella*) *occidentalis* (Ludwig, 1875)	EF, EG, SG, CA	1-99
Stolus cognatus (Lampert, 1885)	EF, SG, CA	0-2
Thyone adinopoda Pawson and Miller, 1981	NG	64-92
+**Thyone crassidisca* Pawson and Miller, 1981	EF, EG	6-45
+**Thyone inermis* Heller, 1868	EG, SG, CA	8-366
**Thyone pawsoni* Tommasi, 1972	EU, EF, EG, CA	6-51
**Thyone pseudofusus* Deichmann, 1930	EU, EF, EG, NG, WG, SG, CA	6-46
Family Psolidae Perrier, 1902		
Psolus operculatus (Pourtalès, 1868)	SG, CA	150-274
**Psolus tuberculosus* Théel, 1886	EU, EF, EG, SG, CA	73-243
Order Aspidochirotida Grube, 1840		
Family Stichopodidae Haeckel, 1896		
+**Astichopus multifidus* (Sluiter, 1910)	EF, BA, EG, SG, CA	1-37
+**Isostichopus badionotus* (Selenka, 1867)	EU, BE, EF, BA, EG, NG, SG, CA	0-55
Eostichopus regalis (Cuvier, 1817)	SG, CA	91-366

TABLE 2 (cont.)

Species	Distribution in Northwest Atlantic Geographic[1]	Bathymetric (m)
Family Holothuriidae Ludwig, 1894		
Actinopyga agassizii (Selenka, 1867)	BE, EF, BA, SG, CA	0-54
Holothuria (*Cystipus*) *occidentalis* Ludwig, 1875	EF, EG[2], CA	69-457
Holothuria (*Halodeima*) *floridana* Pourtalès, 1851	EF, SG, CA	littoral
Holothuria (*Halodeima*) *grisea* Selenka, 1867	EF, BA, SG, CA	littoral
Holothuria (*Halodeima*) *mexicana* Ludwig, 1875	EF, BA, SG, CA	littoral
Holothuria (*Holothuria*) *dakarensis* Panning, 1939	EF, WG	10-54
Holothuria (*Platyperona*) *parvula* (Selenka, 1867)	BE, BA, SG, CA	littoral
Holothuria (*Platyperona*) *rowei* Pawson and Gust, 1981	SG	littoral
Holothuria (*Selenkothuria*) *glaberrima* Selenka, 1867	BA, WG, SG, CA	littoral
**Holothuria* (*Semperothuria*) *surinamensis* Ludwig, 1875	BE, EF, EG, WG, CA	0-42
+**Holothuria* (*Theelothuria*) *princeps* Selenka, 1867	EF, BA, EG, NG, SG, CA	0-54(73)[3]
Holothuria (*Thymiosycia*) *arenicola* Semper, 1868	BE, BA, EF, SG, CA	littoral
+*Holothuria* (*Thymiosycia*) *thomasi* Pawson and Caycedo, 1980	SG, CA	3-30
Holothuria (*Vaneyothuria*) *lentiginosa enodis* Miller and Pawson, 1979	EF, SG, CA	69-466
Family Synallactidae Ludwig, 1894		
Amphigymnas bahamensis Deichmann, 1930	EU, NG, CA	439-586
Bathyplotes natans (Sars, 1868)	EG, NG	408-617
Mesothuria lactea (Théel, 1886)	EU, EG, CA	641-1922
Mesothuria maroccana Perrier, 1902	EG, CA	914-2469
Mesothuria verrilli (Théel, 1886)	EG, CA	699-1828
Pseudostichopus occultatus von Marenzeller, 1893	SG[4], CA	232-1450
Order Elasipodida Théel, 1882		
Family Deimatidae Ekman, 1926		
Deima validum validum Théel, 1879	BA, NG, CA	914-2780
Family Psychropotidae Théel, 1882		
Benthodytes lingua Perrier, 1896	EU, EG, CA	860-2196
Benthodytes typica Théel, 1882	EU, WG, SG, CA	315-2840
Psychropotes depressa (Théel, 1882)	(GOM)[5], CA	2120-3880
Order Molpadiida Haeckel, 1896		
Family Molpadiidae J. Müller, 1850		
Molpadia barbouri Deichmann, 1940	SG, CA	677-1106
Molpadia cubana Deichmann, 1940	NG, WG, SG, CA	24-620
Molpadia musculus (Risso, 1826)	EU, NG	183-2021
Family Caudinidae Heding, 1931		
+*Paracaudina chilensis obesacauda* (Clark, 1907)	EF, EG, WG, SG	0-10
Order Apodida Brandt, 1835		
Family Synaptidae Östergren, 1898		
Euapta lappa (J. Müller, 1850)	BE[6], BA, SG, WG, CA	0-24
Leptosynapta crassipatina Clark, 1924	NG, SG	littoral
Leptosynapta multigranula Clark, 1924	EF, SG	littoral
Protankyra benedeni (Ludwig, 1881)	NG, CA	0-10

TABLE 2 (cont.)

Species	Distribution in Northwest Atlantic Geographic[1]	Bathymetric (m)
Protankyra brychia (Verrill, 1885)	EU, EG, CA	1464-1829
Synaptula hydriformis (Lesueur, 1824)	BE, EF, EG, SG, CA	littoral
Family Chiridotidae Östergren, 1898		
Chiridota rotifera (Pourtalès, 1851)	BE, BA, EF, SG, CA	0-10

*Hourglass species.
+Species taken during other projects (Federal Clam, Shrimp Discard).
[1]See Figure 6 for explanation of geographic regions.
[2]Tommasi, 1973. *Oregon* Station 4092, 18 m, eastern Gulf of Mexico. Probably *Holothuria* (*Theelothuria*) *princeps* Selenka.
[3]Hourglass Station M (73 m), collection data questioned.
[4]Deichmann, 1954. "Northwest of Cuba."
[5]Deichmann, 1930, 1954. Gulf of Mexico, no locality data.
[6]Clark, 1907. Great Sound, Bermuda. Only record to date, unconfirmed.

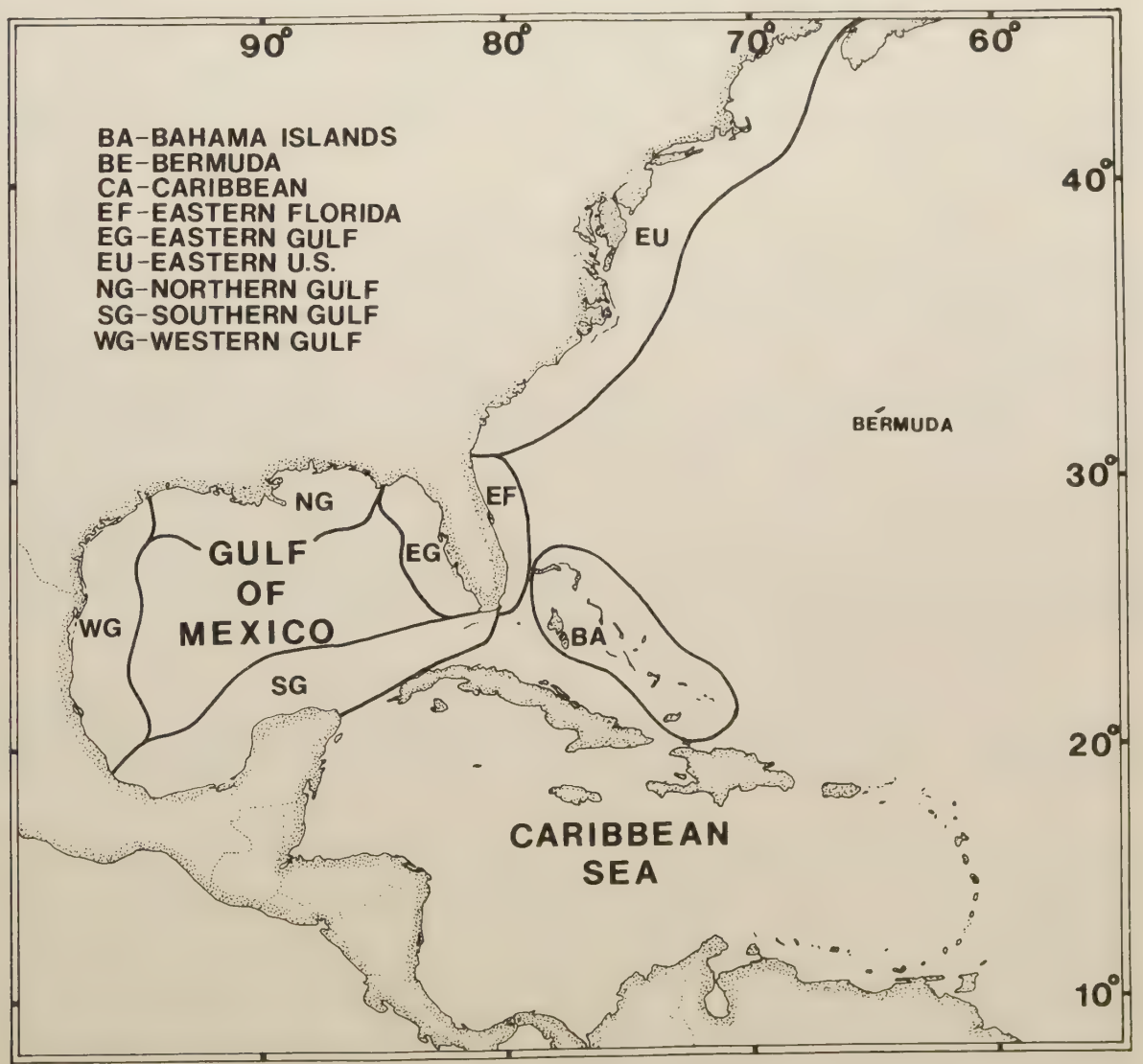

Figure 6. Northwestern Atlantic geographic ranges for Gulf of Mexico holothurians.

KEY TO ORDERS OF HOLOTHUROIDEA OF THE GULF OF MEXICO

1. Tube feet present 2
1. Tube feet absent or markedly reduced 4
2. Tentacles dendritic; introvert present ..... DENDROCHIROTIDA (p. 12)
2. Tentacles shield-shaped; introvert absent 3
3. Respiratory trees present; ossicles usually include tables .... ASPIDOCHIROTIDA (p. 49)
3. Respiratory trees absent; ossicles do not include tables ..... ELASIPODIDA (p. 65)
4. Body stout, tapering to form conspicuous tail; anal papillae and respiratory trees present ..... MOLPADIIDA (p. 65)
4. Body veriform; anal papillae and respiratory trees absent ..... APODIDA (p. 68)

ORDER DENDROCHIROTIDA GRUBE, 1840

Diagnosis: Introvert with retractor muscles present. Tube feet and respiratory trees well developed. Tentacles 10-30, dendritic, richly branched. Calcareous ring simple or complex. Skeleton well developed or reduced.

Remarks: In her comprehensive report on the holothurians of the Gulf of Mexico, Deichmann (1954) introduced several name changes and new combinations, particularly for the Dendrochirotida. Regrettably, she was not aware of Panning's (1949) revision of the Cucumariidae, or she chose to ignore it; none of Panning's nomenclatural changes were adopted, and, consequently, several of Deichmann's new names and new combinations are either objectively or subjectively invalid. To complicate matters further, in the same year that Deichmann's Gulf of Mexico report was published, Heding and Panning (1954) published a revision of the Phyllophoridae; these name changes did not find their way into Deichmann's paper. We have not been able to determine with certainty which publication has priority, and thus we comply with Article 24 of the International Code of Zoological Nomenclature of 1961, in acting as first revisers, adopting as valid the combinations used by Heding and Panning (1954) rather than those used by Deichmann (1954). Table 3 lists the species names applied to Gulf of Mexico Dendrochirotida by Deichmann, and the names that have now been commonly accepted.

Twenty-two species of the order Dendrochirotida are known to occur in the Gulf of Mexico (Table 2). Twelve of these species were taken during Project Hourglass. Two additional species were collected during the Federal Clam Project.

Members of the Dendrochirotida, with their richly branched tentacles, usually feed by capturing small organisms in a feeding net formed by extension of the tentacles upward into the water column (Fish, 1967; Fankboner, 1978). Among the present collections, analysis of intestinal contents for seven species of Dendrochirotida revealed that in the case of three species (*Thyonella sabanillaensis*, *Thyone inermis*, *T. pseudofusus*), 50% or more of the contents consisted of material obtained from the surrounding substratum. It is plausible that these three species, at least, can adopt an alternative feeding method, perhaps when local current activity or water movement decreases to the point where their usual rheophilic feeding method is ineffective.

TABLE 3. DENDROCHIROTID HOLOTHURIAN NAMES EMPLOYED BY DEICHMANN, 1954 AND THEIR CURRENTLY ACCEPTED EQUIVALENTS.

Name Combinations according to Deichmann (1954)	Currently accepted names
Thyone mexicana Deichmann	*Allothyone mexicana* (Deichmann)
Thyone pseudofusus Deichmann	same
Thyone briareus (Lesueur)	*Sclerodactyla briareus* (Lesueur)
Thyone inermis Heller	same
Neothyone belli (Ludwig)	*Pseudothyone belli* (Ludwig)
Thyoneria cognata (Lampert)	*Stolus cognatus* (Lampert)
Thyonella gemmata (Pourtalès)	same
Thyonella sabanillensis (Deichmann)	*Thyonella sabanillaensis* (Deichmann)
Thyonella pervicax (Théel)	same
Euthyonacta solida (Deichmann)	same
Pentacta pygmaea (Théel)	*Ocnus pygmaeus* (Théel)
Trachythyonidium occidentale (Ludwig)	**Phyllophorus* (*Urodemella*) *occidentalis* (Ludwig)
Neophyllophorus destichadus (Deichmann)	**Euthyonidiella destichada* (Deichmann)
Neophyllophorus tritus (Sluiter)	**Euthyonidiella trita* (Sluiter)
Lipotrapeza seguroensis (Deichmann)	**Duasmodactyla seguroensis* (Deichmann)

*As first revisers, we consider the species names marked with an asterisk (that is, names used by Heding and Panning, 1954) valid combinations, and those used by Deichmann (1954) to be invalid.

KEY TO DENDROCHIROTIDA OF THE GULF OF MEXICO

1. Body flattened; dorsal surface covered by conspicuous, overlapping, scale-like plates; ventral surface forming soft sole 2

1. Body usually cylindrical, not covered by conspicuous, scale-like plates; ventral surface not differentiated as sole 3

2. Scales on dorsal surface carrying numerous minute grains; ossicles in sole heavy, knobbed buttons with 4 perforations ..... *Psolus operculatus* (Pourtalès, 1868)

2. Scales on dorsal surface carrying small numbers of low or high proturberances; ossicles in sole knobbed to almost smooth plates with 2 large perforations and variable numbers of smaller perforations ..... *Psolus tuberculosus* Théel, 1886

3. Tube feet restricted to radii; feet completely absent from interradii 4

3. Tube feet scattered on body wall, never restricted to radii, although in some forms ventral feet only may be more or less restricted to radii 5

4. Body wall ossicles include tables; no baskets or buttons ..... *Pentamera pulcherrima* Ayers, 1854

4. Body wall ossicles include baskets and buttons; no tables ..... *Ocnus pygmaeus* (Théel, 1886)

5. Body wall ossicles include tables; no baskets or buttons 6

5. Body wall ossicles include baskets, buttons, or plates; no tables 16

6. Spire of most tables composed of 4 pillars 7

6. Spire of tables composed of 2 pillars 8

7. Radial pieces of calcareous ring comparatively short (Figure 5B); supporting tables of tube feet with elongate disc and low spire ..... *Sclerodactyla briareus* (Lesueur, 1824)

7. Radial pieces of calcareous ring long (Figure 5C); supporting tables of tube feet with short disc and very high, complex spire ..... *Allothyone mexicana* (Deichmann, 1946)

8. Calcareous ring lacking posterior projections ..... *Duasmodactyla seguroensis* (Deichmann, 1930)

8. Calcareous ring with posterior projections 9

9. Tentacles 10; calcareous ring with long posterior projections 10

9. Tentacles normally 20; calcareous ring with short to long posterior projections 14

10. Body wall tables with oval discs, 4 perforations and thick margins 11

10. Body wall tables with mostly irregular discs, few to numerous perforations, and thin margins 13

11. Spires of body wall tables terminate in single blunt spine ..... *Thyone crassidisca* Pawson and Miller, 1981

11. Spires of body wall tables terminate in several short teeth 12

12. Body wall tables with low, truncate spire; ossicles in introvert tables and rosettes ..... *Thyone pseudofusus* Deichmann, 1930

12. Body wall tables with high, tapering spire; ossicles in introvert rosettes only ..... *Thyone adinopoda* Pawson and Miller, 1981

13. Disc of body wall tables with 4-9 perforations; spire of supporting tables in tube feet abruptly tapering ..... *Thyone pawsoni* Tommasi, 1972

13. Disc of some body wall tables with 8-18 perforations; spire of supporting tables in tube feet gently tapering ..... *Thyone inermis* Heller, 1868

14. Tables with strongly dentate margin; two-pillared spire usually reduced to form 4 basal teeth ..... *Phyllophorus* (*Urodemella*) *occidentalis* (Ludwig, 1875)

14. Margin of tables smooth or slightly uneven; spire low or reduced 15

15. Disc of tables oval, usually with 8 perforations; spire low, with few teeth ..... *Euthyonidiella destichada* (Deichmann, 1930)

15. Disc of tables oval to rectangular, usually with 4 perforations; spire often reduced to form 2 knobs ..... *Euthyonidiella trita* (Sluiter, 1910)

16. Calcareous ring with long posterior projections (Figure 5C) 17

16. Calcareous ring lacking posterior projections (Figure 5A) or with very short projections (Figure 5B) 18

17. Body wall ossicles knobbed buttons; feet with supporting tables ..... *Pseudothyone belli* (Ludwig, 1886)

17. Body wall ossicles smooth plates; feet with perforated rods ..... *Stolus cognatus* (Lampert, 1885)

18. Body wall ossicles include baskets 19

18. Body wall ossicles lacking baskets 22

19. Feet most numerous along radii; smooth to knobbed plates with numerous perforations present in body wall 20

19. Feet uniformly scattered over body; perforated plates absent from body wall 21

20. Baskets deep, margin perforate and armed with several blunt teeth ..... *Thyonella sabanillaensis* (Deichmann, 1930)

20. Baskets shallow, flattened, margin solid, formed by 7-9 prominent teeth ..... *Thyonella gemmata* (Pourtalès, 1851)

21. Baskets deep with narrow opening, margin fringed with numerous, irregular, small teeth on both inner and outer side ..... *Euthyonacta solida* (Deichmann, 1930)

21. Baskets shallow, widely open, with 7-10 blunt teeth forming margin ..... *Thyonella pervicax* (Théel, 1886)

22. Body slender, tapering; integument rigid, filled with numerous ossicles; ventral pair of tentacles smaller ..... *Thyonella gemmata* (Pourtalès, 1851)

22. Body barrel-shaped; integument soft, fleshy, ossicles few; tentacles of equal size ..... *Pseudocolochirus mysticus* Deichmann, 1930

Family Cucumariidae Ludwig, 1894

Diagnosis: Body without scale-like plates; ossicles small, inconspicuous; calcareous ring simple, lacking posterior processes.

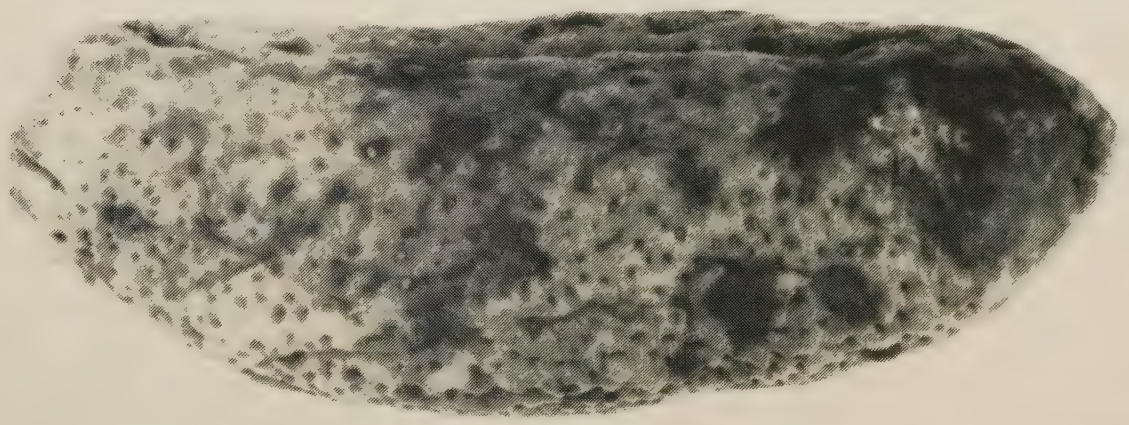

Figure 7. *Euthyonacta solida* (Deichmann), IRCZM 71:087, off Cape Canaveral, Florida, 53 mm TL, lateral view.

Euthyonacta solida (Deichmann, 1930)

Figures 7, 8

Thyone solida Deichmann, 1930, p. 172, pl. 15, figs. 11-17, pl. 16, figs. 1, 2; Caso, 1961, p. 364, pl. 19, figs. 1-6.

Ludwigia solida: Panning, 1949, p. 431.

Euthyonacta solida: Deichmann, 1954, p. 399; Caso, 1955, p. 521, pl. 8, figs. 1-6; Panning, 1971, p. 37.

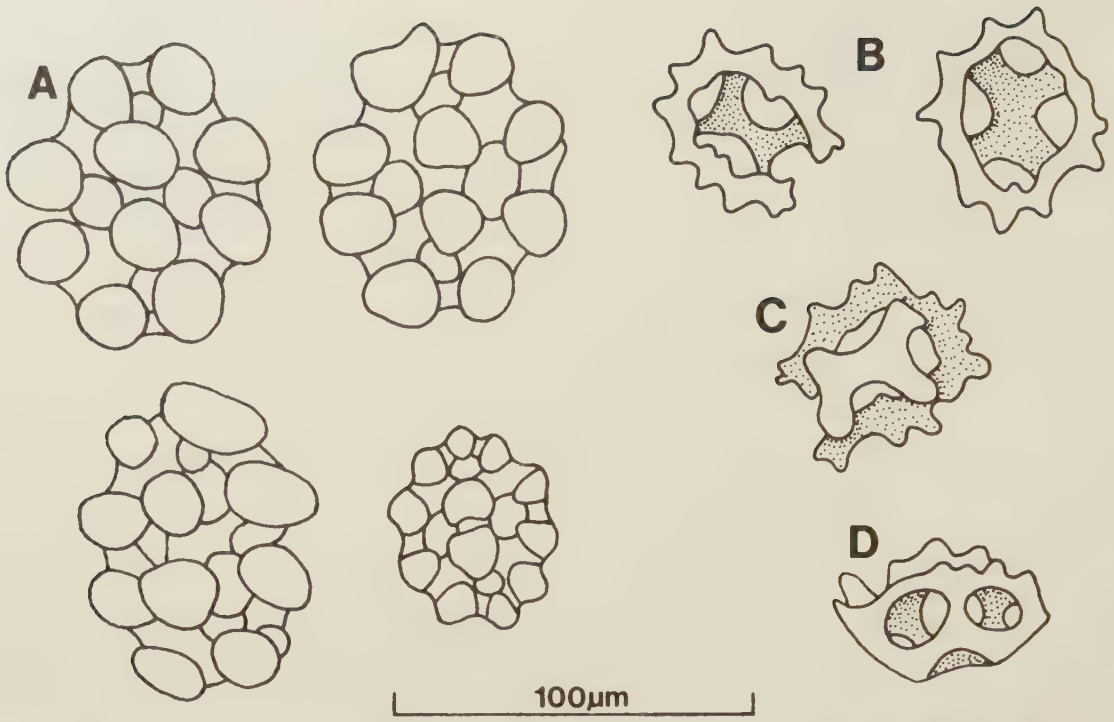

Figure 8. *Euthyonacta solida* (Deichmann), skeletal ossicles. A. knobbed buttons from body wall; B. baskets from body wall, dorsal view; C. same, ventral view; D. same, lateral view.

Material examined: HOURGLASS STATION D: 1, 22 mm; 27 March 1966; dredge; USNM E 22332. — 1, 16 mm; 3 March 1967; dredge; FSBC I 24419.

Diagnosis: Small form, 10-60 mm long, with barrel-shaped body, strongly contracted in preserved specimens. Anteriorly, 5 prominent oral valves concealing mouth. Podia uniformly scattered over entire body surface, capable of complete retraction. Integument thick, filled with ossicles consisting of deep baskets and buttons; no plates. Coloration in life orange-brown with darker mottling.

Ossicles: Body wall — Outer layer of deep baskets, 40-60 µm diameter, with rim bearing numerous teeth on inner and outer surfaces; regular buttons of variable size, 55-100 µm long, 45-80 µm wide, with strongly knobbed surface and 4 perforations. Podia — Numerous thick supporting rods with small perforations; end plate absent.

Type-specimen: National Museum of Natural History, Smithsonian Institution, USNM E 16253.

Type-locality: Gulf of Mexico, *Albatross* Station 2369, 29°16′30″N, 85°32′00″W, 48 m.

Distribution: Previously reported only from the Gulf of Mexico, off northwest Florida, and near Veracruz, Mexico; 6-124 m. One of us (JEM) has examined several specimens collected off east-central Florida in 22-40 m (Figure 9). Hourglass Station D; 55 m.

Bottom type: Sediments at Station D were composed of crushed shell, *Lithothamnion* spp., Foraminifera tests and brown silt.

Remarks: Deichmann (1954) erected the genus *Euthyonacta* for *Thyone solida* Deichmann, 1930. Caso (1955) followed Deichmann's new assignment to *E. solida* but subsequently (Caso, 1961)

reverted to the combination *T. solida*. Since no explanation was given, it is not known whether this step was intentional or simply a *lapsus calami*.

Figure 9. Geographic distributions of *Euthyonacta solida* and *Ocnus pygmaeus* in the northwestern Atlantic and the Gulf of Mexico.

Ocnus pygmaeus (Théel, 1886)

Figures 10, 11

Colochirus pygmaeus Théel, 1886a, p. 92, pl. 4, fig. 9.

Pentacta pygmaea: Deichmann, 1930, p. 180, pl. 21, figs. 10-16; H. L. Clark, 1933, p. 116; Engel, 1939, p. 11; Deichmann, 1954, p. 399, fig. 67 (4-11); Martínez de Rodríguez and Herminson, 1975, p. 194, pl. 5, figs. 1-3; Deichmann, 1963, p. 110.

Ocnus pygmaeus: Panning, 1949, p. 437.

Pentacta pygmaeus: Tommasi, 1969, p. 14, fig. 20.

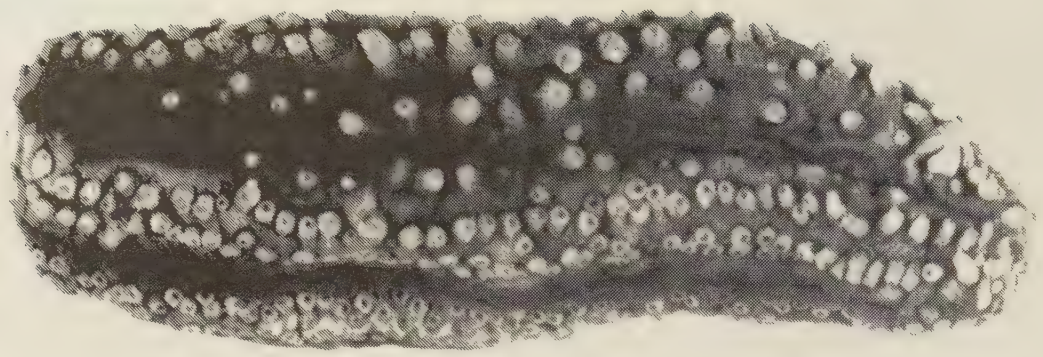

Figure 10. *Ocnus pygmaeus* (Théel), FSBC I 24441, Hourglass Station I, 47 mm TL, lateral view.

Material examined: HOURGLASS STATION A: 1, 32 mm; 1 August 1966; dredge; FSBC I 24480. — HOURGLASS STATION B: 1, 43 mm; 30 August 1965; trawl; FSBC I 24431. — 1, 43 mm; 20 February 1966; dredge; FSBC I 24432. — 1, 28 mm; 20 January 1967; dredge; FSBC I 24433. — 2, 14, 22 mm; 5 February 1967; dredge; FSBC I 24434. — 1, 17 mm; 2 March 1967; trawl; FSBC I 24435. — 1, 7 mm; 14 March 1967; dredge; FSBC I 24436. — HOURGLASS STATION C: 4, 57-73 mm; 2 May 1966; trawl; FSBC I 24437. — HOURGLASS STATION I: 2, 48, 53 mm; 3 September 1965; trawl; FSBC I 24438. — 1, 43 mm; 12 November 1965; dredge; FSBC I 24439. — 1,

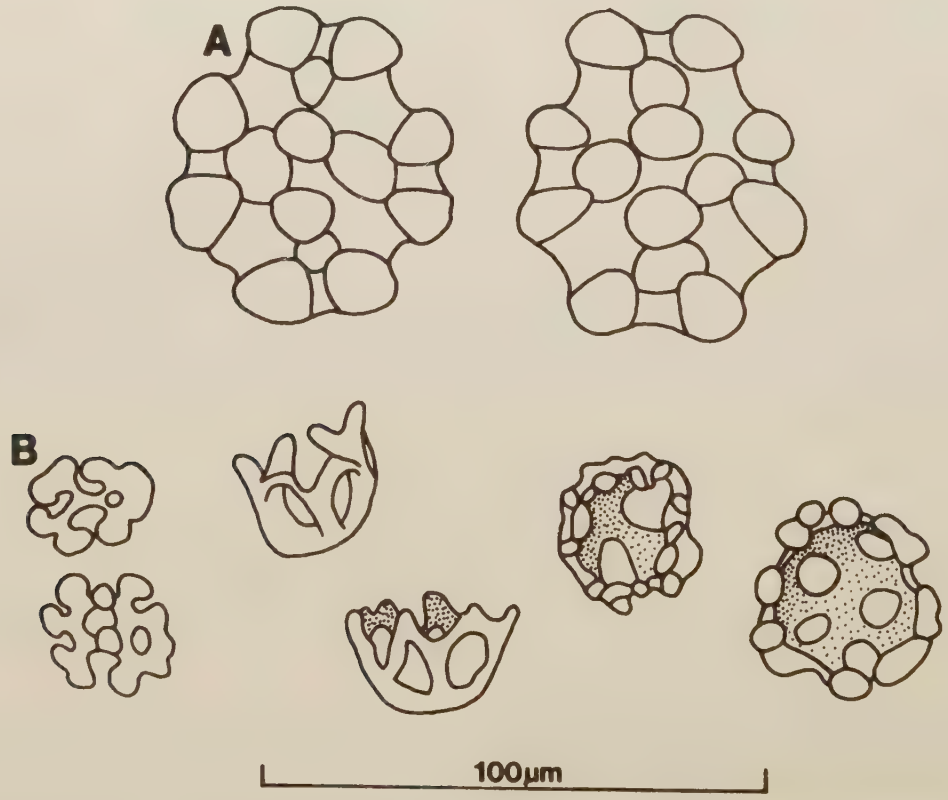

Figure 11. *Ocnus pygmaeus* (Théel), skeletal ossicles. A. knobbed buttons from body wall; B. various stages of baskets from same.

68 mm; 6 December 1965; dredge; FSBC I 24440. — 5, 44-59 mm; 9 March 1966; trawl; FSBC I 24441. — 1, 53 mm; 21 March 1966; trawl; FSBC I 24442. — 1, 23 mm; 11 April 1966; trawl; FSBC I 24443. — 1, 55 mm; 12 June 1966; trawl; FSBC I 24444. — 2, 39, 48 mm; 5 July 1966; trawl; USNM E 22330. — 2, 22, 24 mm; 5 August 1966; dredge; FSBC I 24445. — 1, 21 mm; 5 August 1966; trawl; FSBC I 24446. — 1, 42 mm; 15 February 1967; dredge; IRCZM 71:143. — 1, 9 mm; 14 November 1967; dredge; FSBC I 24447. — FEDERAL CLAM: 1, 70 mm; 31 July 1969; trynet; 27°38′53″N, 82°41′45″W; 0.9-1.5 m; FSBC I 24448. — 1, 25 mm; 18 July 1971; hydraulic dredge; 26°36.0′N, 82°14.4′W; 5.5 m; FSBC I 24449. — NO DATA: 1, 30 mm; FSBC I 29185. — 1, 60 mm; FSBC I 29186.

Diagnosis: Small species, 30-70 mm. Body form characteristic, with heavy, conspicuous tube feet confined to 5 radii. Mouth concealed by prominent oral valves. Body wall rigid, with numerous ossicles consisting of buttons and baskets. Coloration in life light to chocolate brown.

Ossicles: Body wall — Outer layer of deep, irregular baskets, 25-35 μm diameter, with conspicuous knobbed margin; inner layer of regular buttons, 45-80 μm long, 35-60 μm wide, with 10 knobs and 4 perforations. Podia—Large supporting rods, 330-430 μm long, often triradiate; end plates present but not common.

Type-specimen: British Museum (Natural History).

Type-locality: Bahia, Brazil.

Distribution: Previously known from South Carolina, Florida, Campeche, Mexico, Puerto Rico, Grenada, Venezuela, Trinidad, and Brazil (Figure 9). We have examined specimens from off Cape Lookout, North Carolina (northern range extension). Hourglass Stations A, B, C, and I (Table 4). Bathymetric range 0-37 m.

TABLE 4. NUMBERS OF *Ocnus pygmaeus* COLLECTED DURING PROJECT HOURGLASS, BY STATION AND MONTH.

Ocnus pygmaeus																													
STA	1965					1966														1967									TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A														1																	1
B_1		1																			2	1									4
B_2							1												1			1									3
C_1										4																					4
C_2																															
D_1																															
D_2																															
E																															
I		2		1	1			6	1		1	2		3							1									1	19
J																															
K																															
L																															
M																															
TOT		3		1	1		1	6	1	4	1	2		4					1		3	2								1	31

Subscripts 1, 2 and sp designate regular, post and supplementary cruises.

Bottom type: Sediments at Stations A and I were composed of quartz sand and crushed shell covered with a fine layer of silt. The bottom at Station B was characterized by shell and quartz sand

covered with *Caulerpa* and *Halophila*. Station C sediments consisted of crushed shell and other organically derived calcium particles covered with a heavy layer of white calcareous silt.

Gear selectivity: Nineteen Hourglass specimens were captured by trawl, 12 with the dredge.

Remarks: T. C. Shirley (personal communication) has discovered a very peculiar habitat preference for *O. pygmaeus*. Collecting in the southern Gulf near Campeche, he found five specimens deep inside sponges. For several of these specimens, there was no apparent means of entry. This is the first record of *O. pygmaeus* occurring in the southern Gulf.

Thyonella gemmata (Pourtalès, 1851)

Figures 12, 13

Colochirus gemmatus Pourtalès, 1851, p. 11.

Thyone gemmata: Deichmann, 1930, p. 177, pl. 17, figs. 1-3.

Ludwigia gemmata: Panning, 1949, p. 432, figs. 23-25.

Thyonella gemmata: Deichmann, 1954, p. 398; Manwell and Baker, 1963, p. 40, figs. 2, 3; Menzel, 1971, p. 87; Panning, 1971, p. 36; Pawson, 1977, p. 13; Harry, 1979, p. 41.

Figure 12. *Thyonella gemmata* (Pourtalès), FSBC I 24368, off Cedar Key, Florida, 64 mm TL, lateral view.

Material examined: HOURGLASS STATION A: 1, 20 mm; 31 August 1966; dredge; FSBC I 24363. — HOURGLASS STATION I: 1, 58 mm; 14 February 1966; dredge; FSBC I 24364. — FEDERAL CLAM: 1, 80 mm; 13 October 1969; hydraulic dredge; 29°09′N, 83°06′W; 3 m; FSBC I 24365. — 1, 95 mm; 13 October 1969; hydraulic dredge; 29°09′N, 83°05′W; 1.5 m; FSBC I 24366. — 5, 55-79 mm; 14 October 1969; hydraulic dredge; 29°07′N, 83°04′W; 1.5 m; IRCZM 71:136. — 1, 92 mm; 11 November 1969; hydraulic dredge; 29°23′N, 83°21′W; 3.6 m; FSBC I 24367. — 4, 80-110 mm; 25 November 1969; hydraulic dredge; 29°09′N, 83°07′W; 1.5-3.0 m; USNM E 22321. — 1, 64 mm; 26 November 1969; hydraulic dredge; 29°12′N, 83°07′W; 2.1-3.0 m; FSBC I 24368. — 2, 63, 70 mm; 26 November 1969; hydraulic dredge; 29°11′N, 83°07′W; 2.1 m; FSBC I 24369. — 1, 55 mm; 4 December 1969; hydraulic dredge; 29°07′N, 82°58′W; 1.5-2.1 m; FSBC I 24370. — 2, 80, 90 mm; 5 December 1969; hydraulic dredge; 29°14′N, 83°11′W; 0.6-2.1 m; FSBC I 24371. — 4, 30-70 mm; 6 December 1969; hydraulic dredge; 29°11′N, 83°07′W; 2.1 m; FSBC I 24372. — 1, 55 mm; 16 January 1970; hydraulic dredge; 30°17.75′N, 86°05.3′W; 12.4 m; FSBC I 24373. — 1, 110 mm; 24 April 1970; hydraulic dredge; 29°00.8′N, 83°09.15′W; 6 m; FSBC I 24374. —

1, 80 mm; 18 July 1971; hydraulic dredge; 26°36.0'N, 82°14.3'W; 3.1 m; FSBC I 24375. — 1, 64 mm; 20 August 1971; hydraulic dredge; 25°27.9'N, 81°19.4'W; 4.6 m; FSBC I 24376. — 1, 102 mm; 22 August 1971; hydraulic dredge; 25°34.8'N, 81°38.3'W; 7.6 m; FSBC I 24377. — 1, 80 mm; 23 August 1971; hydraulic dredge; 25°48.2'N, 81°43.6'W; 6.1 m; FSBC I 24378.

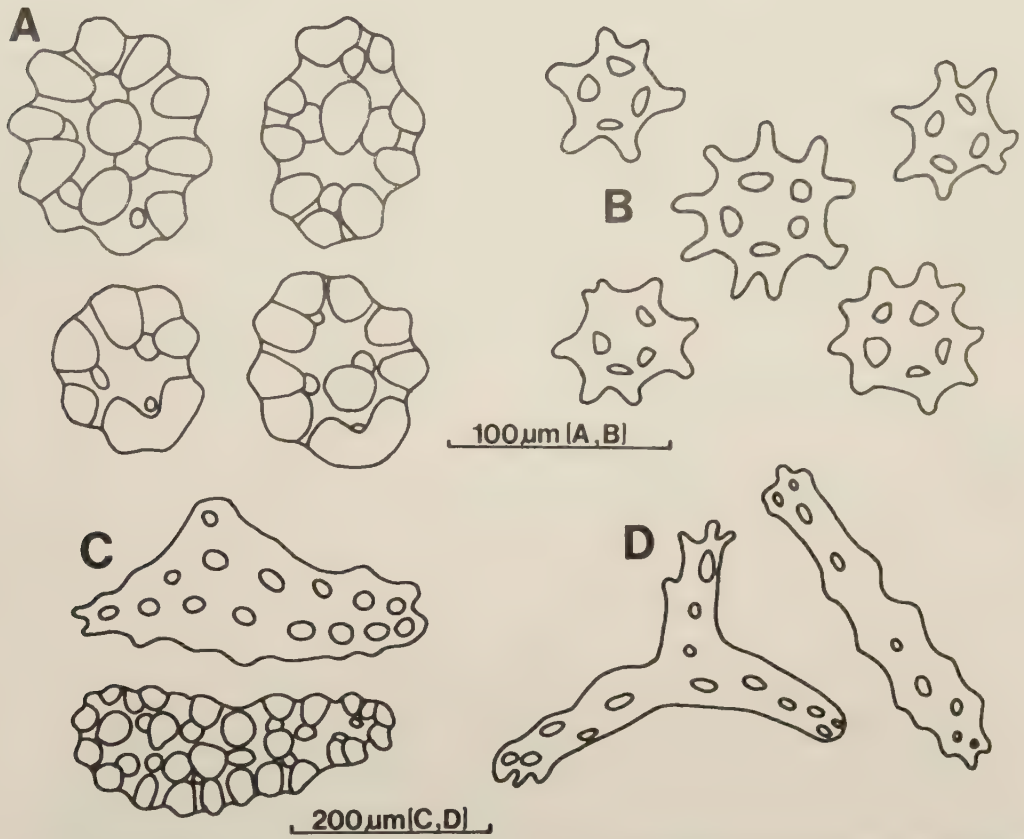

Figure 13. *Thyonella gemmata* (Pourtalès), skeletal ossicles. A. knobbed buttons from body wall; B. shallow baskets from same; C. perforated plates from same; D. perforated rods from same.

Diagnosis: Medium-size, burrowing form up to 150 mm. Body straight to slightly curved or U-shaped, swollen medially, slender near ends. Podia cylindrical medially, papillate distally, arranged in double rows along radii, scattered in interradii. Body wall rigid, with ossicles consisting of buttons, shallow baskets and perforated plates. Coloration in life grey to mottled brown.

Ossicles: Body wall — Baskets usually present, sometimes absent (see remarks); when present, number variable, shallow, flattened, 45-55 µm diameter, with 4 central perforations and 7-9 prominent teeth; variously shaped knobbed buttons, 80-120 µm long, 60-85 µm wide, with reduced perforations. Podia — Slender, slightly curved rods, often tri-armed, perforated along their length, 210-365 µm long. Introvert — Numerous small rosettes collected in heaps; scattered spectacle-shaped rods.

Type-specimen: Type apparently lost (Deichmann, 1930, 1954).

Type-locality: Sullivan Island, South Carolina.

Distribution: Common in shallow water, 0-6 m, from New England to Florida and along the Gulf coast (Figure 14); not reported from the Bahamas or the Caribbean. Hourglass Stations A and I.

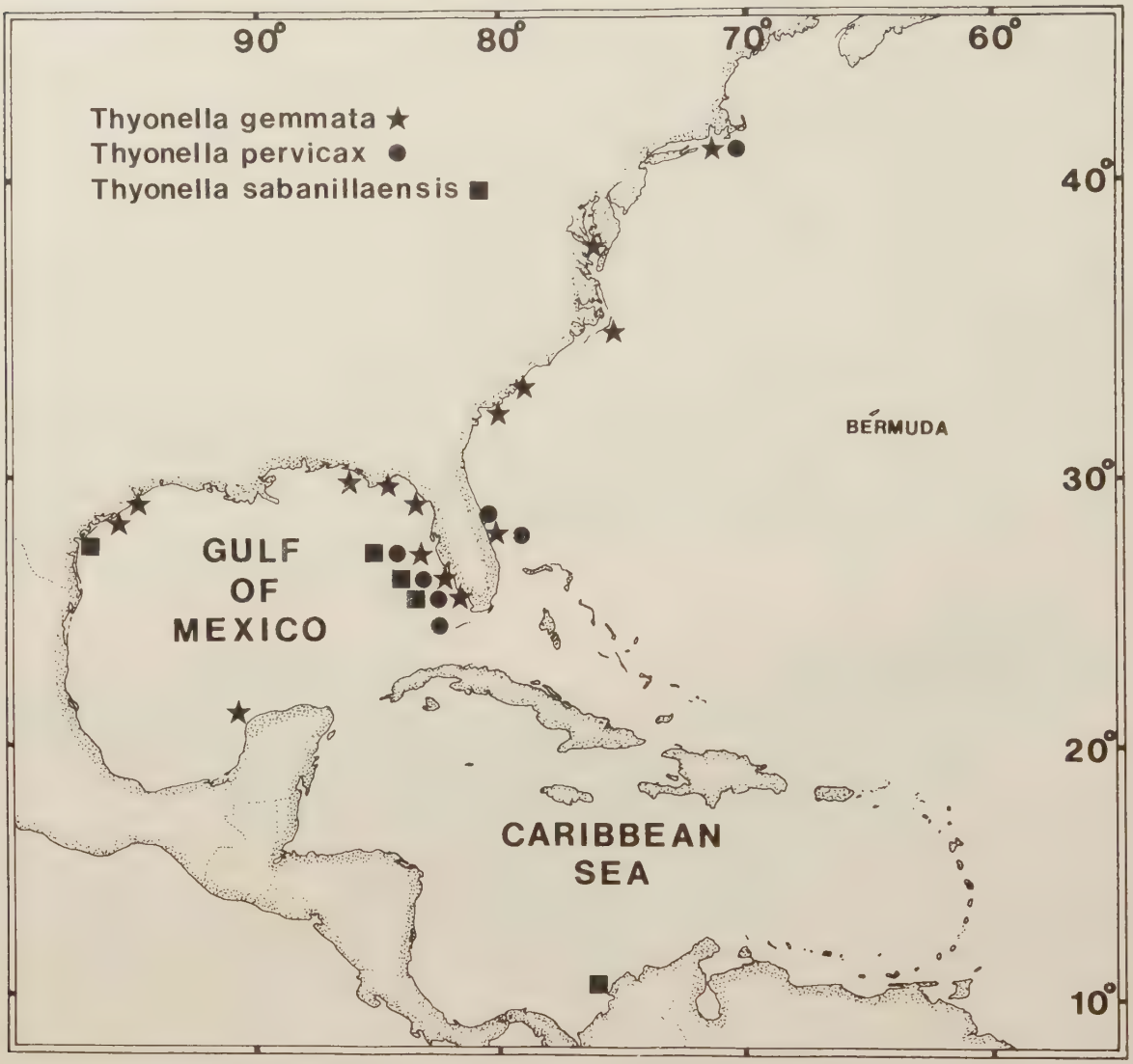

Figure 14. Geographic distributions of *Thyonella gemmata*, *T. pervicax* and *T. sabanillaensis* in the northwestern Atlantic and the Gulf of Mexico.

Bottom type: In the Indian River, east-central Florida, *T. gemmata* is frequently collected in the shoal grass, *Halodule*. Along the Atlantic seaboard of the U.S., it occurs buried in mud or sand. Specimens collected during Project Hourglass were taken from bottoms of quartz sand and crushed shell covered with a fine layer of silt.

Diet: Gut analysis revealed 85% amorphous material, 15% diatom tests and a few sponge spicules.

Morphological variation: Manwell and Baker (1963), working at Alligator Harbor, Florida, discovered two populations of *T. gemmata* which differed slightly in morphological and behavioral characteristics. Examination of the hemoglobin and esterase electrophoretic patterns from both groups led them to suspect that the populations were genetically isolated and represented separate

sibling species. Taxonomically, the "sibling species" were not segregated pending examination of populations from other localities.

Gear selectivity: Both Hourglass specimens and the specimens captured during the Federal Clam Project were taken with dredges.

Remarks: This species is one of the most frequently encountered holothurians in the eastern Gulf. Occasionally, large numbers can be found washed ashore after storms. As in many holothurians, the ossicles of *Thyonella gemmata* vary considerably throughout the body wall. In both the anterior and posterior regions, there are numerous, large perforated plates with smooth to heavily knobbed surfaces. These plates are seldom found in the middle portion of the body, where buttons and baskets prevail. To further complicate matters, the characteristic baskets, which are invaluable for identification, are completely lacking in some specimens, apparently resorbed with age. Fortunately, the baskets of *T. sabanillaensis* are always present and serve to separate these closely related congeners.

Thyonella pervicax (Théel, 1886)

Figures 15, 16

Thyone pervicax Théel, 1886a, p. 93, pl. 5, fig. 9, pl. 2, fig. 3; Deichmann, 1930, p. 175, pl. 16, figs. 9-12; Brito, 1962, p. 4; Tommasi, 1969, p. 13, fig. 16.

Thyonella pervicax: Deichmann, 1954, p. 399, fig. 67 (12-20); Pawson, 1977, p. 13.

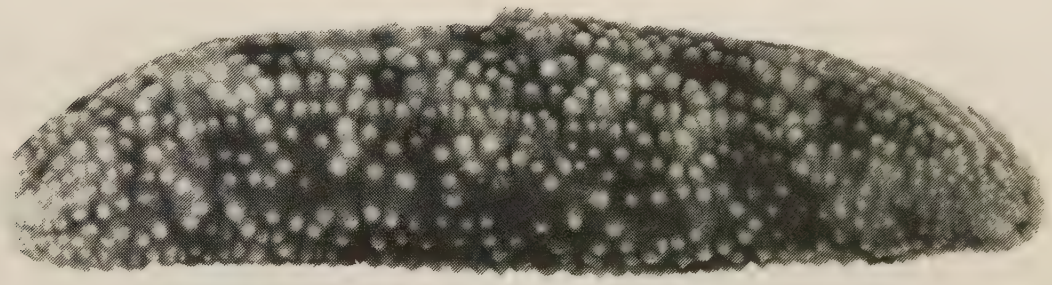

Figure 15. *Thyonella pervicax* (Théel), FSBC I 24414, off Gasparilla Island, Florida, 53 mm TL, lateral view.

Material examined: HOURGLASS STATION B: 1, 50 mm; 6 June 1966; dredge; FSBC I 24403. — 1, 58 mm; 2 July 1966; dredge; FSBC I 24404. — 1, 51 mm; 6 November 1966; dredge; FSBC I 24405. — 1, 50 mm; 20 January 1967; dredge; USNM E 22337. — 1, 45 mm; 3 April 1967; dredge; FSBC I 24406. — HOURGLASS STATION C: 1, 48 mm; 11 August 1967; dredge; FSBC I 24407. — HOURGLASS STATION I: 1, 50 mm; 11 May 1966; dredge; FSBC I 24408. — HOURGLASS STATION J: 2, 40, 45 mm; 21 March 1966; dredge; FSBC I 24409. — 1, 43 mm; 5 August 1966; dredge; FSBC I 24410. — 1, 45 mm; 4 September 1966; dredge; FSBC I 24411. — 2, 43, 48 mm; 12 January 1967; dredge; IRCZM 71:139. — 1, 50 mm; 11 October 1967; dredge; FSBC I 24412. — FEDERAL CLAM: 1, 50 mm; 19 May 1971; box dredge; 26°03.1′N, 81°57.7′W; 10.7 m; FSBC I 24413. — 4, 22 (curved), 53 mm; 19 July 1971; box dredge; 26°51.4′N, 82°28.3′W; 13.7 m; FSBC I 24414. — 1, 41 mm; 19 July 1971; box dredge; 26°54.6′N, 82°31.5′W; 13.7 m; FSBC I 24415. — SHRIMP DISCARD: 1, 63 mm; 7-10 July 1978; double 65 ft shrimp trawl; 26°43′N, 82°19′W to 26°47′N, 82°24′W; 10.3-13.7 m; FSBC I 24416.

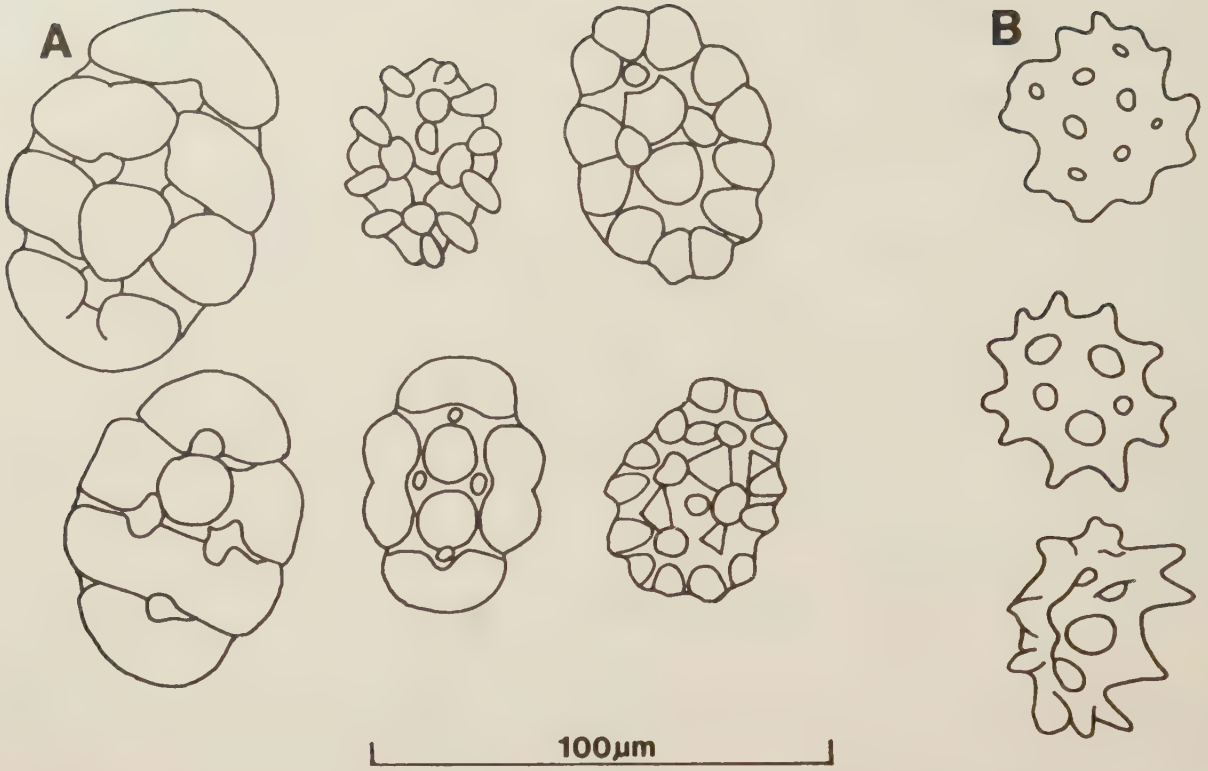

Figure 16. *Thyonella pervicax* (Théel), skeletal ossicles. A. knobbed buttons from body wall; B. shallow baskets from same.

Diagnosis: Small, burrowing form, 40-70 mm long. Body tapering toward blunt ends. Conical podia uniformly distributed over body surface, retracted to low warts in preserved specimens. Body wall thick, rigid, filled with ossicles consisting of buttons and shallow baskets; no perforated plates. Coloration in life light tan with darker mottling.

Ossicles: Body wall — Outer layer of shallow, flat baskets with 10-12 marginal teeth, 40-60 µm diameter; inner layer of strongly knobbed buttons in two distinct sizes, 60-90 µm long, 35-55 µm wide, and 35-55 µm long, 27-35 µm wide; variable number of knobbed spherical plates. Podia — Thick, tapering supporting rods with few perforations; end plate poorly developed or absent. Introvert — Buttons and shallow baskets; no rosettes.

Type-specimen: British Museum (Natural History).

Type-locality: Bahia, Brazil.

Distribution: Reported from Vineyard Sound, Massachusetts, eastern Florida, Dry Tortugas, the eastern Gulf of Mexico and Bahia, Brazil in 6-40 m (Figure 14). Hourglass Stations B, C, I, J (Table 5).

Bottom type: Twelve of the 14 specimens collected were taken at Stations B and J, with bottom sediments of shell and quartz sand often covered with the green alga, *Caulerpa*, and the sea grass, *Halophila*.

Gear selectivity: All Hourglass specimens were captured by the dredge, most likely due to the burrowing nature of this species.

TABLE 5. NUMBERS OF *Thyonella pervicax* COLLECTED DURING PROJECT HOURGLASS, BY STATION AND MONTH.

Thyonella pervicax

STA	1965					1966													1967											TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A																															
B_1											1	1					1						1								4
B_2																			1												1
C_1																															
C_2																											1				1
D_1																															
D_2																															
E																															
I										1																					1
J								2						1	1				2										1		7
K																															
L																															
M																															
TOT								2		1	1	1		1	1		1		3				1				1		1		14

Subscripts 1, 2 and sp designate regular, post and supplementary cruises.

Remarks: *Thyonella pervicax* and a congener, *T. gemmata*, are two of the most common holothurian species occurring in the eastern Gulf.

Thyonella sabanillaensis (Deichmann, 1930)

Figures 17, 18

Thyone sabanillaensis Deichmann, 1930, p. 178, pl. 17, figs. 4-9.

Thyonacta sabanillensis: Deichmann, 1941, p. 101; Panning, 1949, p. 436.

Thyonella sabanillensis: Deichmann, 1954, p. 399; Panning, 1971, p. 36; Harry, 1979, p. 42, pl. 10, figs. 53-57.

Thyonacta sabanillaensis: Cherbonnier, 1957, p. 537, figs. 1, 2; 1959, p. 440; Tommasi, 1969, p. 15, fig. 22.

Figure 17. *Thyonella sabanillaensis* (Deichmann), FSBC I 25007, from Tampa Bay, Florida, 90 mm TL, lateral view.

Material examined: HOURGLASS STATION J: 1, 43 mm; 12 January 1967; dredge; FSBC I 24426. — FEDERAL CLAM: 1, 90 mm; 13 June 1969; hydraulic dredge; 27°35′11″N, 82°45′15″W;

2.7 m; IRCZM 71:141. — 1, 120 mm; 23 August 1971; hydraulic dredge; 25°43.9′N, 81°42.2′W; 6.1 m; USNM E 22336.

Diagnosis: Medium-sized, burrowing form, 40-150 mm long. Body U-shaped, tapering toward distinctly pentagonal ends. Podia cylindrical medially, papilliform near mouth and anus, numerous on radii, scattered interradially, especially medially and ventrally. Body wall rigid, with ossicles consisting of buttons, deep baskets and perforated plates. Coloration in life greyish brown.

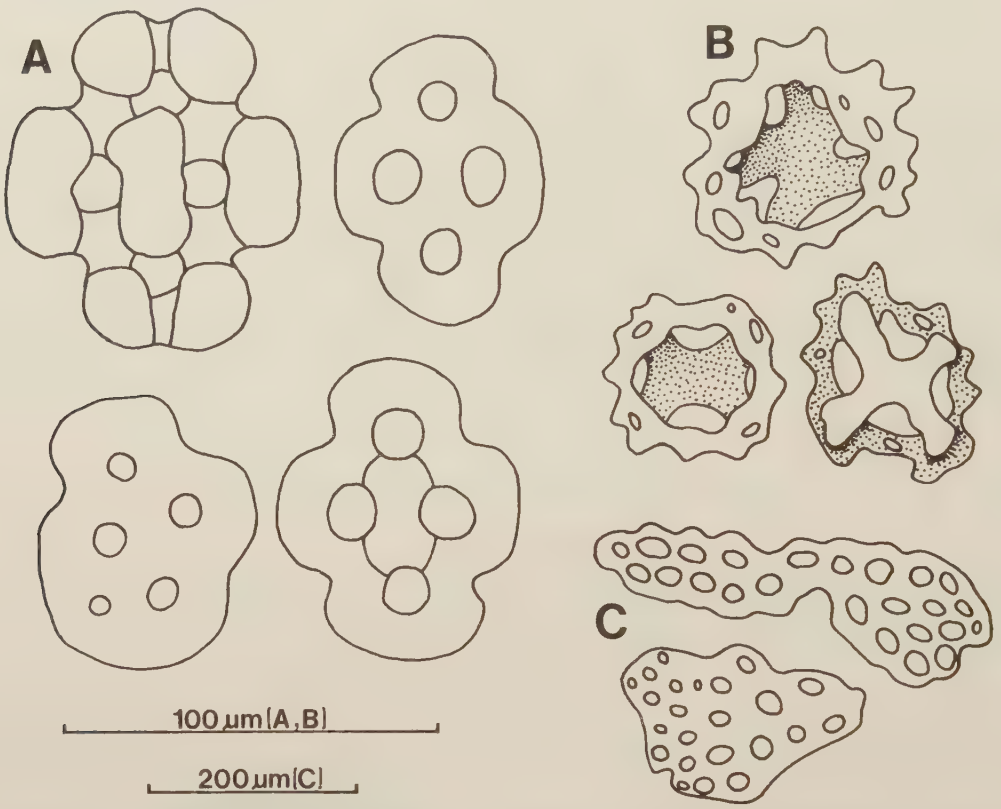

Figure 18. *Thyonella sabanillaensis* (Deichmann), skeletal ossicles. A. buttons from body wall; B. baskets from same; C. perforated plates from same.

Ossicles: Body wall — Outer layer of flattened baskets, 45-65 µm diameter; rim of baskets irregular, perforate, armed with several blunt teeth; inner layer of smooth to strongly knobbed buttons, 60-115 µm long, 45-100 µm wide, with 4 perforations; variable number of smooth to knobbed perforated plates. Podia — Numerous, thick supporting rods with small perforations; no end plate. Introvert — Numerous small rosettes.

Type-specimen: National Museum of Natural History, Smithsonian Institution, USNM E 2659.

Type-locality: Sabanilla, Colombia.

Distribution: Previously reported from Texas, Colombia and French Guiana (Figure 14). Specimens examined during this study represent the first record from the eastern Gulf of Mexico. One specimen was collected at Hourglass Station J. Bathymetric range, 4-30 m.

Bottom type: Sediments at Station J were composed of shell and quartz sand covered with extensive growths of *Caulerpa* and *Halophila.*

Diet: Gut analysis revealed 45% quartz sand and 45% amorphous material. Additional food items consisted of diatoms, sponge spicules, forams and echinoid spines.

Remarks: Although a member of the plankton-feeding order Dendrochirotida, this species also has the capacity to obtain food items by deposit feeding.

Family Sclerodactylidae Panning, 1949

Diagnosis: Body without scale-like plates; ossicles small, inconspicuous; calcareous ring complex, with posterior processes of radial ossicles solid or composed of a few pieces.

Pseudothyone belli (Ludwig, 1886)

Figures 19, 20

Thyone belli Ludwig, 1886, p. 21, pl. 1, fig. 6; Deichmann, 1930, p. 176, pl. 14, figs. 10-13; Brito, 1962, p. 4; Tommasi, 1969, p. 13, fig. 15; 1971, p. 2.

Cucumaria argillacea Sluiter, 1910, p. 336, fig. B (a-c); Deichmann, 1930, p. 160.

Thyone micropunctata Sluiter, 1910, p. 338, fig. D (a-c); Deichmann, 1930, p. 171, pl. 14, figs. 14-18.

Pseudothyone belli: Panning, 1949, p. 456.

Neothyone belli: Deichmann, 1954, p. 397, fig. 67 (21, 22).

Material examined: HOURGLASS STATION A: 1, 16 mm; 3 January 1966; dredge; FSBC I 24379. — 1, 23 mm; 3 March 1966; dredge; USNM E 22321. — HOURGLASS STATION C: 1, 12 mm; 7 February 1966; dredge; FSBC I 24380. — 1, 8 mm; 8 September 1966; dredge; FSBC I 24381. — 3, 10-12 mm; 19 November 1966; dredge; IRCZM 71:137. — 1, 11 mm; 1 December 1966; dredge; FSBC I 24382. — 9, 6-15 mm; 13 December 1966; dredge; FSBC I 24383. — 3, 9-13 mm; 6 January 1967; dredge; FSBC I 24384. — 5, 10-13 mm; 20 January 1967; dredge; FSBC I 24385. — 5, 8-13 mm; 5 February 1967; dredge; FSBC I 24386. — 1, 13 mm; 2 March 1967; trawl; FSBC I 24387. — 4, 4-11 mm; 2 March 1967; dredge; FSBC I 24388. — 1, 15 mm; 3 April 1967; trawl; FSBC I 24389. — 5, 6-12 mm; 3 April 1967; dredge; FSBC I 24390. — 1, 4 mm; 20 May 1967; trawl; FSBC I 24391. — 1, 9 mm; 21 June 1967; dredge; FSBC I 24392. — 1, 11 mm; 21 November 1967; dredge; FSBC I 24393. — HOURGLASS STATION K: 2, 8, 8 mm; 13 January 1966; dredge; FSBC I 24394. — 1, 25 mm; 15 February 1967; trawl; FSBC I 24395. — 3, 14-16 mm; 8 March 1967; dredge; FSBC I 24396.

Diagnosis: Small, burrowing form, up to 50 mm. Body cylindrical, curved. Podia numerous, scattered over entire body. Integument rigid, with ossicles consisting of buttons and supporting tables. Coloration in preserved specimens greyish.

Ossicles: Body wall — Buttons with 10 marginal knobs, 2 central knobs, 4 perforations; present in 2 distinct sizes, 90-110 μm long, 55-75 μm wide, and 70-85 μm long, 40-50 μm wide. Podia — Robust, elongate, supporting tables 125-190 μm long, 60-100 μm high; spire strong, terminating in several small teeth; end plate well developed.

Type-specimen: Würzburg Museum, West Germany, according to Deichmann (1954).

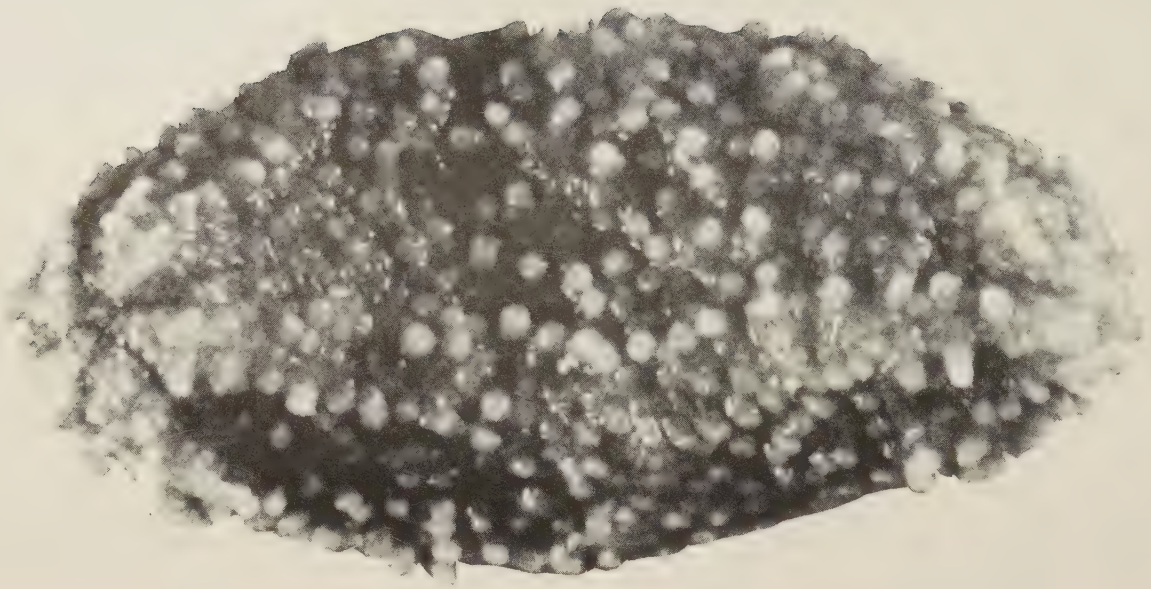

Figure 19. *Pseudothyone belli* (Ludwig), IRCZM 71:137, Hourglass Station C, 12 mm TL, dorsal view.

Type-locality: Abrolhos Reefs, Bahia, Brazil.

Distribution: Known from east Florida, off Ft. Pierce (JEM, personal observation), west Florida off Tampa (this study), Dry Tortugas, Panama, Trinidad, Tobago and Brazil (Figure 21). Hourglass Stations A, C, K (Table 6). Bathymetric range, 0-37 m. The Hourglass specimens represent the first record in the eastern Gulf and are the northernmost individuals collected to date.

Bottom type: Ninety-six percent of the Hourglass specimens were collected from biogenically derived calcium sediments covered with a dense layer of white calcareous silt.

Gear selectivity: Due to the burrowing habits of this species, 46 of the 50 Hourglass specimens were taken by dredge (Table 6).

Seasonality: Over a two-year period, 94% of the specimens were taken during the months of November to April (Table 6).

Remarks: Quantitatively, *P. belli* represents 23% of the total number of holothurians collected during Project Hourglass.

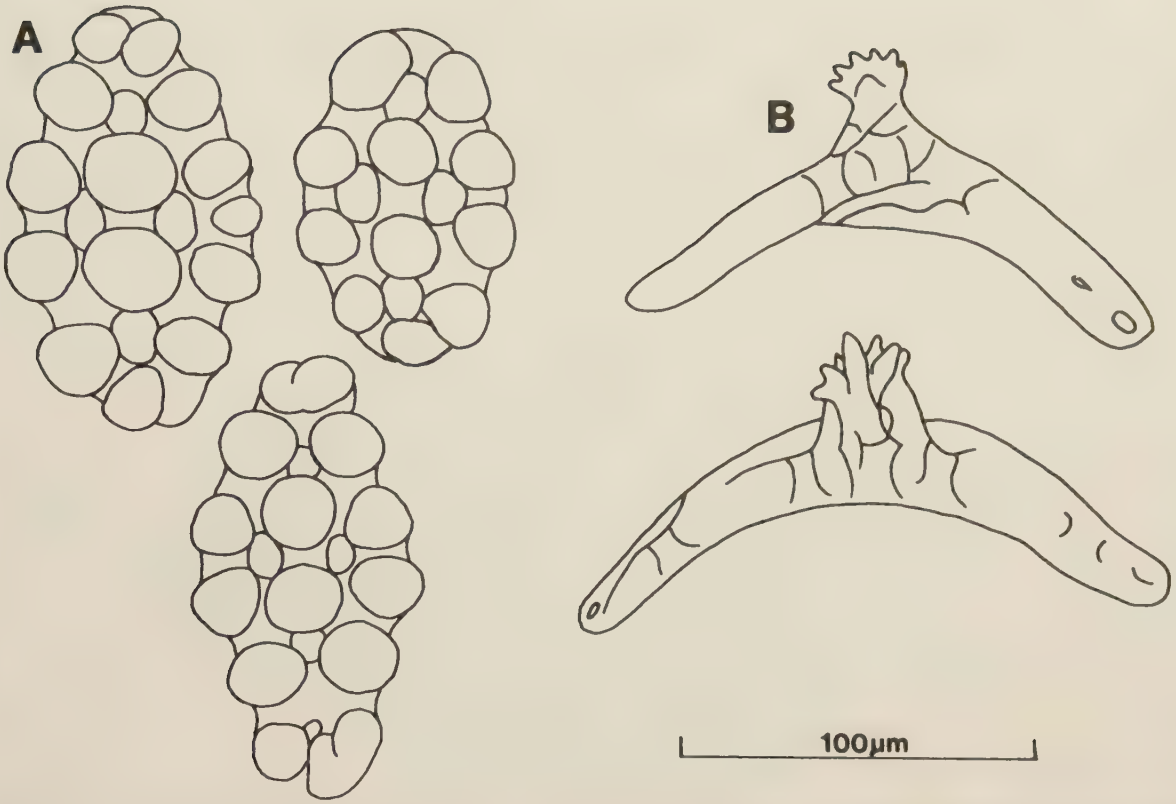

Figure 20. *Pseudothyone belli* (Ludwig), skeletal ossicles. A. knobbed buttons from body wall; B. supporting tables from podia, lateral view.

TABLE 6. NUMBERS OF *Pseudothyone belli* COLLECTED DURING PROJECT HOURGLASS, BY STATION AND MONTH.

Pseudothyone belli

STA	1965					1966													1967										TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A						1		1																							2
B_1																															
B_2																															
C_1							1											1	3		5	5	6								21
C_2															1		3	9	5					1	1					1	21
D_1																															
D_2																															
E																															
I																															
J																															
K						2															1	3									6
L																															
M																															
TOT						3	1	1							1		3	10	8		6	8	6	1	1					1	50

Subscripts 1, 2 and sp designate regular, post and supplementary cruises.

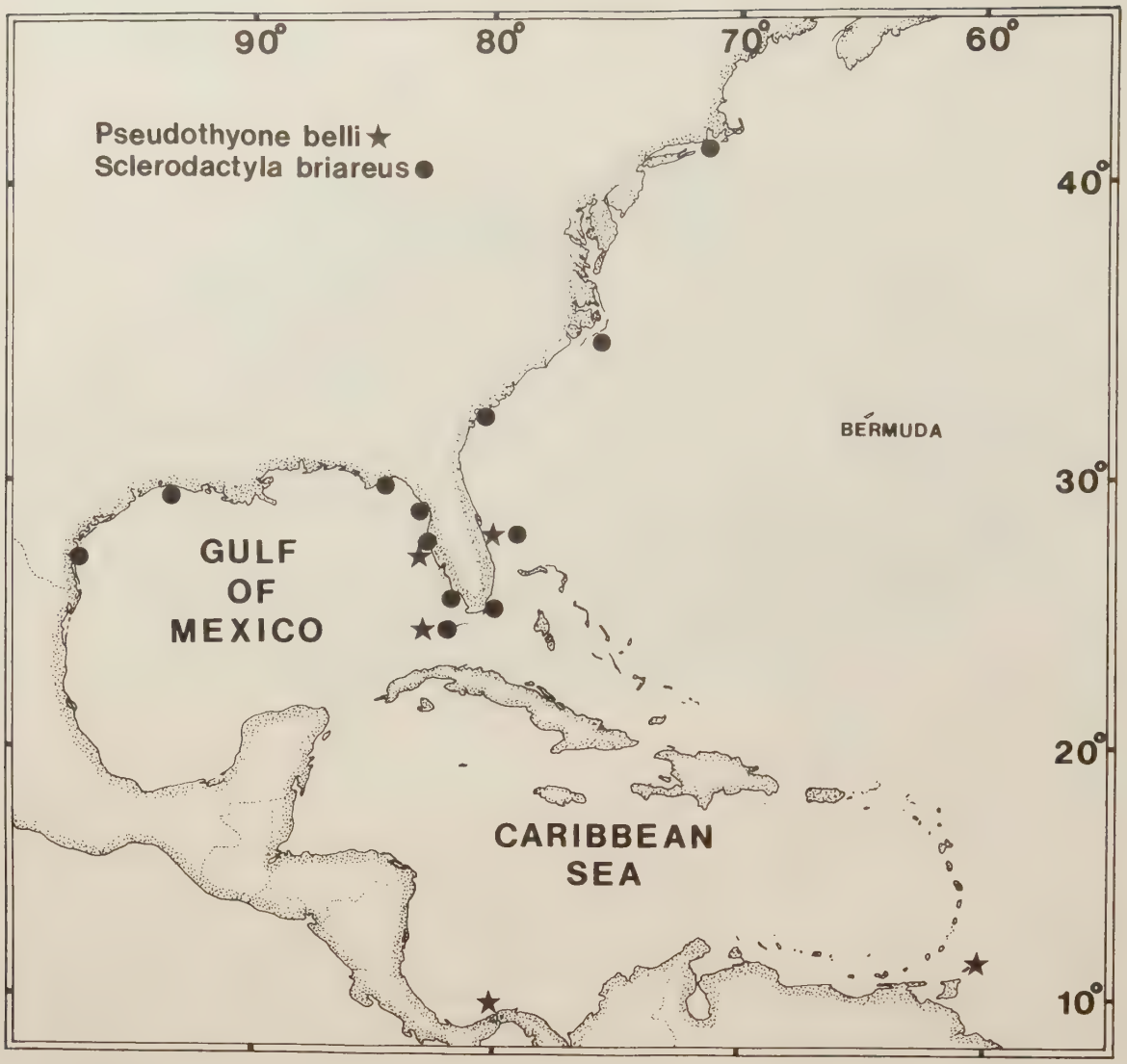

Figure 21. Geographic distributions of *Pseudothyone belli* and *Sclerodactyla briareus* in the northwestern Atlantic and the Gulf of Mexico.

Sclerodactyla briareus (Lesueur, 1824)

Figures 22, 23

Holothuria briareus Lesueur, 1824, p. 161.

Thyone briareus: Pearse, 1908, p. 259; Oshima, 1925, p. 420; Deichmann, 1930, p. 165, pl. 13, figs. 5-7; H. L. Clark, 1933, p. 133; Kille, 1935, p. 82; Deichmann, 1939, p. 134; Kille, 1939, p. 70; Deichmann, 1946, p. 3; Colwin, 1948, p. 296; Deichmann, 1954, p. 395; Farmanfarmaian, 1969a, p. 118; 1969b, p. 132; Menzel, 1971, p. 87; Harry, 1979, p. 40, pl. 8, figs. 46-48.

Sclerodactyla briareus: Panning, 1949, p. 459; Pawson, 1977, p. 8.

Material examined: HOURGLASS MATERIAL: None. — FEDERAL CLAM: 1, 40 mm; 17 April 1969; hydraulic dredge; 27°41′37″N, 82°31′34″W; 1.5 m; FSBC I 24420. — 1, 45 mm; 14 October 1969; hydraulic dredge; 29°07′N, 83°04′W; 1.5 m; FSBC I 24421. — 3, 24-65 mm; 6 November 1969; hydraulic dredge; 29°41′N, 83°32′W; 1.2-3.0 m; IRCZM 71:140. — 1, 40 mm; 7 November 1969;

hydraulic dredge; 29°41′N, 83°33′W; 2.4-3.0 m; FSBC I 24422. — 1, 60 mm; 6 December 1969; hydraulic dredge; 29°11′N, 83°07′W; 2.1 m; FSBC I 24423. — 1, 47 mm; 21 August 1971; hydraulic dredge; 25°47.2′N, 81°36.3′W; 3.7 m; FSBC I 24519. — 1, 50 mm; 21 August 1971; hydraulic dredge; 25°44.9′N, 81°38.4′W; 4 m; FSBC I 24424. — 1, 40 mm; 21 August 1971; hydraulic dredge; 25°45.7′N, 81°34.3′W; 3.4 m; USNM E 22335. — SHRIMP DISCARD: 1, 50 mm; 3-6 August 1978; 72 ft shrimp trawl; 24°57′N, 82°10′W; 22.8-24.3 m; FSBC I 24425.

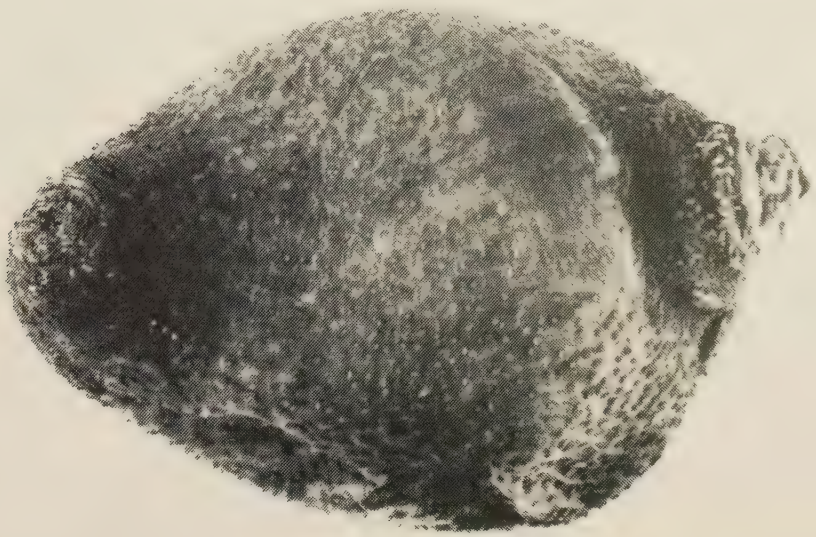

Figure 22. *Sclerodactyla briareus* (Lesueur), IRCZM 71:140, Deadman Bay, Florida, 65 mm TL, dorsal view.

Diagnosis: Medium-size, burrowing form, up to 120 mm long. Body barrel-shaped, tapering only at anterior and posterior extremes. Podia numerous, hairlike, scattered over entire body. Body wall thin, with ossicles consisting of tables; no buttons. Coloration in life green or brown to nearly black.

Ossicles: Body wall — Tables with four-pillared spire, 45-85 μm high, terminating in several spines; disc with irregular margin, 60-80 μm diameter, usually 4 central and 4 marginal perforations. Podia — Strong, elongate supporting tables with curved disc, 130-170 μm diameter, robust spire, 90-110 μm high; large end plate present. In large individuals, most ossicles may be resorbed with only a few remaining near anus.

Type-specimen: Museum of Comparative Zoology, Harvard University, Cambridge, Mass., MCZ 254.

Type-locality: Texas; no locality given.

Distribution: Ranges from Nova Scotia south along the eastern U.S. to the Gulf coast of Texas in 0-24 m (Figure 21). Although no specimens were collected during Project Hourglass, several specimens were taken along the west coast of Florida during the Federal Clam Project.

Bottom type: This species prefers soft muddy bottoms usually associated with sea grasses. Adults live buried just beneath the sediment, but juveniles have been found attached to seagrass blades (Deichmann, 1954).

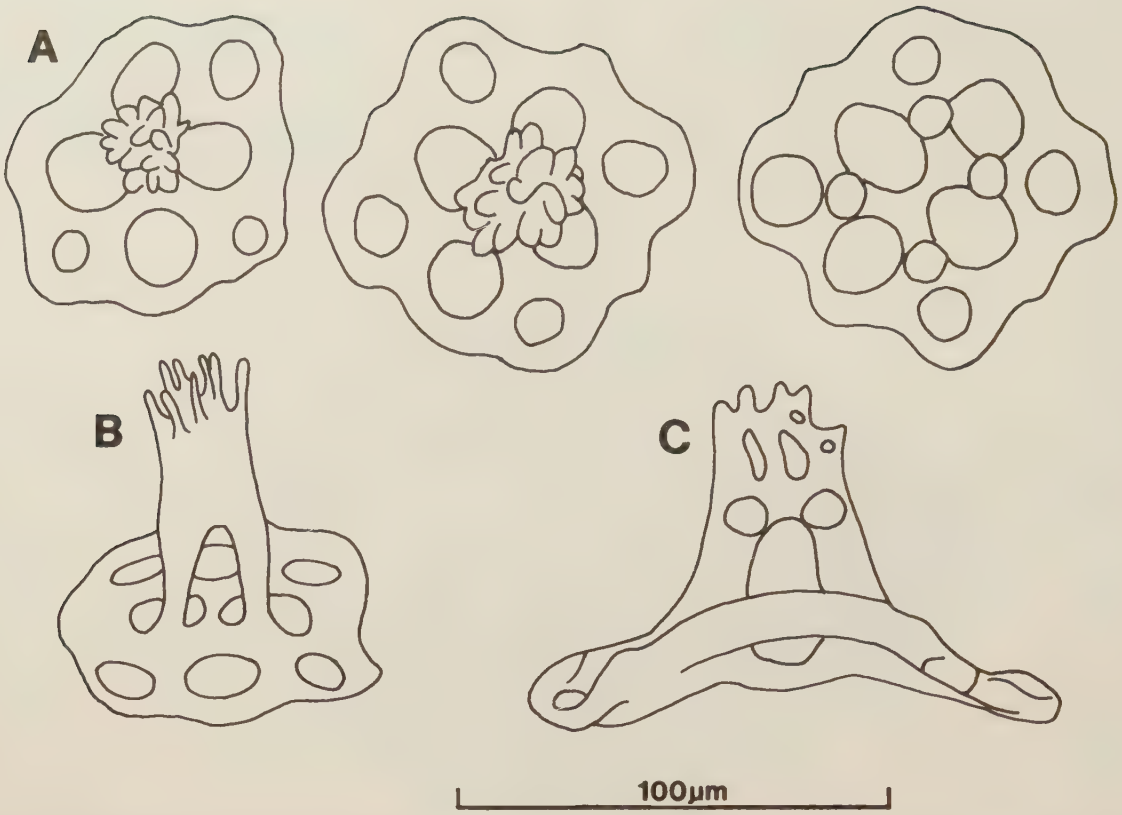

Figure 23. *Sclerodactyla briareus* (Lesueur), skeletal ossicles. A. body wall tables, dorsal view; B. same, lateral view; C. supporting table from podia.

Diet: Gut analysis revealed 85% amorphous material (found to be rich in diatom tests at 200X), 10% algae and 5% quartz sand. *Sclerodactyla briareus* is a characteristic suspension feeder.

Reproduction and development: Oshima (1925) determined that fertilized eggs develop into creeping larvae in 3.5 days. By three months, the juveniles are complete with skeletal elements like those found in adults. At one year, the juveniles measure 2 cm in length but lack genital organs. Development of genital structures requires several years; spawning is usually initiated during the fifth year. The breeding season and spawning behavior were studied by Colwin (1948), who noted that June was the principal month for shedding at Woods Hole, Mass.

Behavior: Pearse (1908) conducted a major study on several behavioral aspects of *S. briareus* (=*T. briareus*), including response to stimuli, locomotion, feeding and respiratory movements. Pearse found that *S. briareus* displayed varying degrees of coordination during normal activities (i.e., locomotion, feeding). He noted that many of the posterior feet remained attached to the substrate during locomotion on a solid surface, breaking away only when the forceful exertion of the anterior feet became greater. This relatively poor correlation was contrasted to feeding behavior in which the tentacles displayed a high degree of coordination in bringing food items into the mouth.

Through mechanical stimulation of bisected specimens, Pearse discovered that the frequency of characteristic reactions was greater in the posterior segments. This, he theorized, was due to the eviseration and regeneration capabilities of *S. briareus*. The process of eviseration in *S. briareus* is accomplished by autonomy of the tentacular crown, the anterior portion of the body wall and some

of the visceral organs. Following eviseration, the cast-off structures degenerate and die, leaving the posterior body wall to regenerate new organs.

Physiology: Kille (1935) found that eviscerated specimens of *S. briareus* (=*T. briareus*) were able to regenerate their digestive tracts within 15 to 22 days. For regeneration of gonadal tissue, Kille (1939) noted that the gonad-basis and some germ cells must remain following evisceration. In specimens which had undergone a complete gonadectomy, no regeneration of gonadal tissues occurred.

Farmanfarmaian (1969a, b), investigating intestinal absorption and transport in *S. briareus* (=*T. briareus*), rejected theories of previous workers who believed that wandering coelomocytes were responsible for nutritional transport. Farmanfarmaian's experiments provided evidence to support his contention that the perivisceral fluid serves as the main circulatory medium in holothurians.

Remarks: *Sclerodactyla briareus* has long been known as *Thyone briareus* and under this name has been studied extensively by physiologists and biochemists. Panning (1949), in a revision of the cucumariid holothurians, referred *T. briareus* to the resurrected genus-name *Sclerodactyla*, a step amply justified by the peculiar nature of the ossicles in this species.

Family Phyllophoridae Östergren, 1907

Diagnosis: Body without scale-like plates; ossicles small, inconspicuous; calcareous ring complex, with posterior processes composed of mosaic of minute pieces.

Allothyone mexicana (Deichmann, 1946)

Figures 24, 25

Thyone mexicana Deichmann, 1946, p. 1, fig. 1; 1954, p. 395, fig. 67 (1-3); Harry, 1979, p. 41, pl. 9, figs. 49-52.

Material examined: HOURGLASS MATERIAL: None. — FEDERAL CLAM: 1, 90 mm; 11 November 1969; hydraulic dredge; 29°18′N, 83°16′W; 2.1-3.0 m; FSBC I 24510. — 1, 65 mm; 19 November 1969; hydraulic dredge; 29°09′N, 83°06′W; 1.2-1.5 m; FSBC I 24511. — 1, 49 mm; 25 November 1969; hydraulic dredge; 29°07′N, 83°04′W; 3.0 m; FSBC I 24512. — 1, 50 mm; 25 November 1969; hydraulic dredge; 29°09′N, 83°07′W; 1.5-3.0 m; FSBC I 24513. — 1, 24 mm; 26 November 1969; hydraulic dredge; 29°12′N, 83°07′W; 2.1-3.0 m; FSBC I 24514. — 1, 93 mm; 5 December 1969; hydraulic dredge; 29°14′N, 83°11′W; 0.6-2.1 m; FSBC I 24515. — 2, 51, 95 mm; 6 December 1969; hydraulic dredge; 29°11′N, 83°07′W; 2.1 m; USNM E 22333. — 3, 125-200 mm; 15 December 1969; hydraulic dredge; 30°12.7′N, 85°52.6′W; 6.4 m; IRCZM 71:148.

Diagnosis: Large, burrowing form, up to 200 mm long, with U-shaped body. Numerous cylindrical podia arranged in indistinct radii and scattered in interradii, especially of the ventral surface. Tentacles 10, ventral pair smaller. Body wall ossicles include 4 pillared tables. Coloration in preserved specimens tan to grey-brown.

Ossicles: Body wall — Large tables with 4-pillar spire; disc diameter 45-120 μm; spire height 35-105 μm. Podia — Robust, elongate supporting tables with curved disc and enormous reticulate spire, 60-145 μm high, 80-165 μm long; end plate present.

Figure 24. *Allothyone mexicana* (Deichmann), IRCZM 71:148, off Panama City, Florida, 135 mm TL, lateral view.

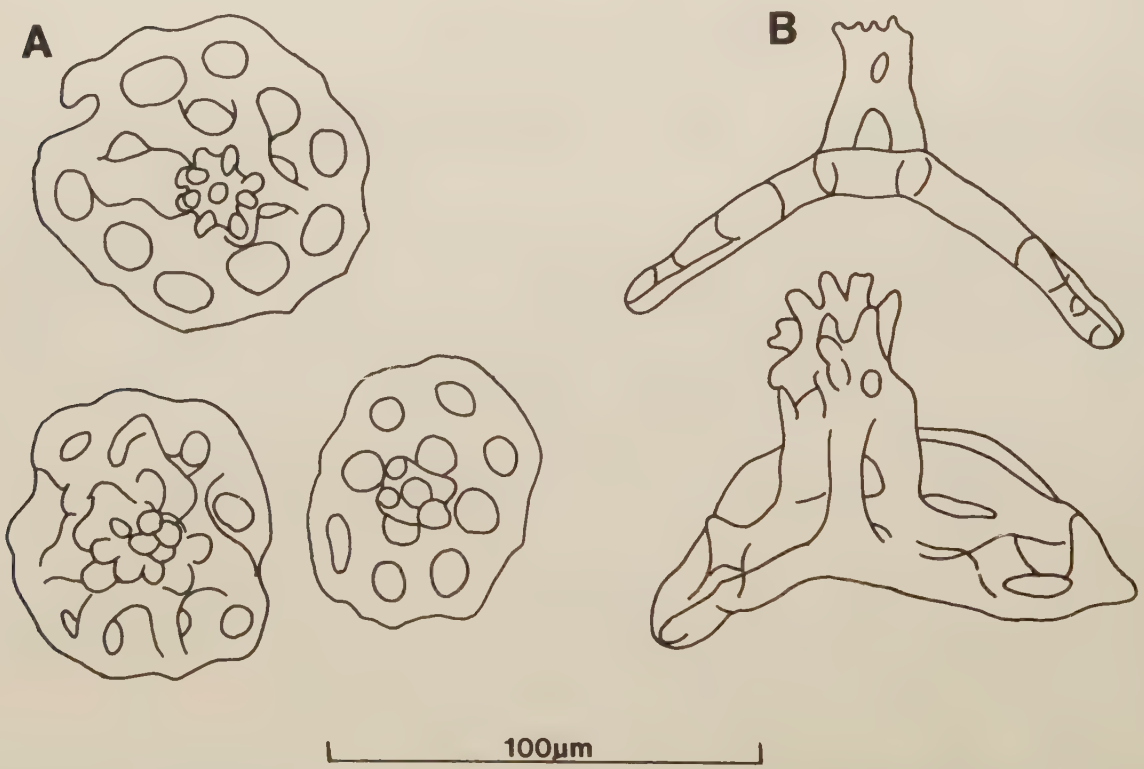

Figure 25. *Allothyone mexicana* (Deichmann), skeletal ossicles. A. tables from body wall, dorsal view; B. supporting tables from podia, lateral view.

Type-specimen: National Museum of Natural History, Smithsonian Institution, USNM E 10555.

Type-locality: Sugarhouse Bend, Barataria Bay, Grand Isle, Louisiana.

Distribution: Presently found only in the Gulf of Mexico from northwest Florida to Texas; 0-6 m. Specimens collected during the Federal Clam Project and examined for this study are the first specimens to be collected along the Florida coast (Figure 26). No specimens were taken during Project Hourglass.

Diet: Gut contents included 70% amorphous material, 20% diatom remains and 10% quartz sand.

Remarks: Deichmann (1946) described *A. mexicana* from a juvenile specimen 2.5 cm in length. In her specimen, the disc of the body wall tables had several circles of perforations and a knobbed margin. Examination of adult *A. mexicana* from this study reveals that body wall tables further develop so that a complicated, robust spire often conceals the perforations and knobbed margin (Figure 25).

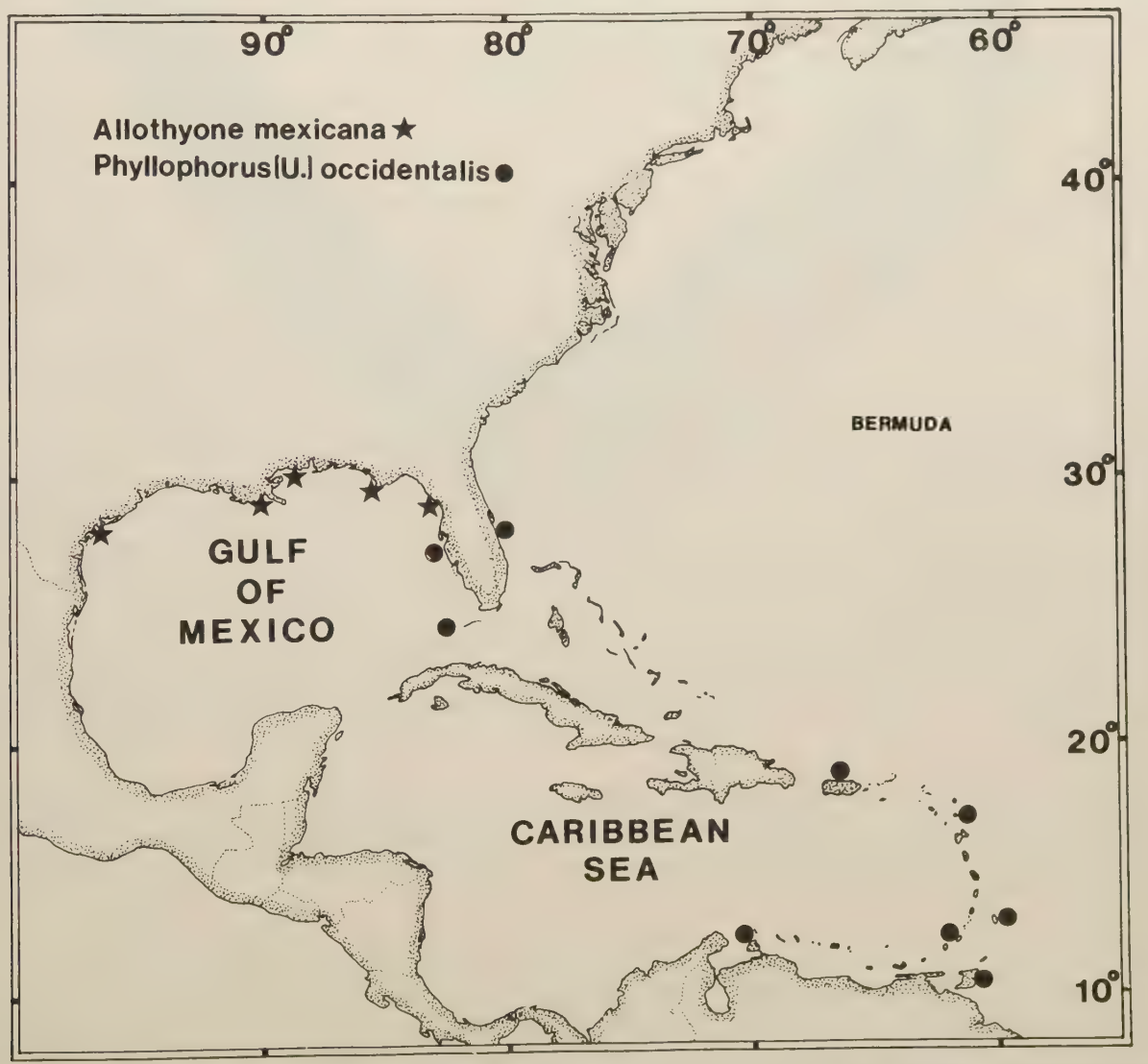

Figure 26. Geographic distributions of *Allothyone mexicana* and *Phyllophorus* (*Urodemella*) *occidentalis* in the northwestern Atlantic and the Gulf of Mexico.

Phyllophorus (*Urodemella*) *occidentalis* (Ludwig, 1875)

Figures 27, 28

Thyonidium occidentale Ludwig, 1875, p. 119.

Thyone constituta Sluiter, 1910, p. 340, fig. F.

Phyllophorus occidentalis: Deichmann, 1930, p. 148, pl. 18, figs. 1-2; H. L. Clark, 1933, p. 112.

Euthyonidium occidentalis: Deichmann, 1938, p. 380; 1941, p. 124.

Phyllophorus (Urodemella) occidentalis: Heding and Panning, 1954, p. 164, fig. 76; Domantay, 1959, p. 191; Tommasi, 1969, p. 10, fig. 10.

Trachythyonidium occidentale: Deichmann, 1954, p. 402, fig. 68 (1-5); 1963, p. 111; Tikasingh, 1963, p. 96, figs. 63-69.

Figure 27. *Phyllophorus* (*Urodemella*) *occidentalis* (Ludwig), IRCZM 71:119, off Ft. Pierce, Florida, 80 mm TL, lateral view.

Material examined: HOURGLASS STATION A: 1, 17 mm; 1 December 1966; dredge; FSBC I 24417.

Diagnosis: Medium-size, burrowing form, up to 100 mm. Body cylindrical, U-shaped, slightly tapering toward blunt, rounded ends. Tentacles 20, alternating large and small. Podia arranged along radii and uniformly scattered over entire body. Ossicles consisting of uniform tables. Coloration in life yellow, orange or dark brown.

Ossicles: Body wall and podia — Tables of one type, 55-65 μm long, 40-55 μm wide; disc with dentate margin and 4-8 perforations; spire usually reduced to 4 basal teeth.

Type-specimen: Unknown, possibly in Germany (Deichmann, 1954).

Type-locality: Surinam.

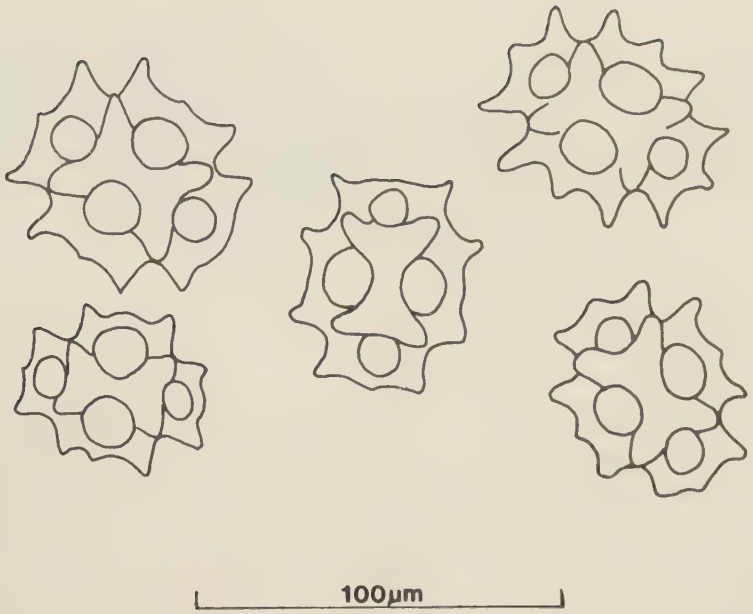

Figure 28. *Phyllophorus* (*Urodemella*) *occidentalis* (Ludwig), skeletal ossicles, tables from body wall.

Distribution: Known from east and west Florida, Dry Tortugas, Puerto Rico, Antigua, Barbados, Grenada, Trinidad, Venezuela, Surinam, and Brazil (Figure 26). One specimen was collected at Hourglass Station A. Bathymetric range, 1-99 m.

Bottom type: Sediments at Station A consisted primarily of quartz sand and crushed shell hash covered with a fine layer of silt.

Remarks: Deichmann (1939) erected the genus *Euthyonidium*, type species *Phyllophorus seguroensis* Deichmann, 1930, and included in her new genus *Phyllophorus occidentalis* (Ludwig). In 1954, Deichmann proposed "*Trachythyonidium* nom. nov." as a replacement name for *Euthyonidium*, noting in a footnote (p. 402) that "The name *Euthyonidium* Deichmann, 1939 has been withdrawn as a complete synonym of *Pentadactyla* Hutton, which has been reinstated." *Pentadactyla* Hutton, 1878, was erected with *Thyone longidentis* Hutton, 1872, as the type-species by original designation (monotypy), and thus *Euthyonidium*, with a completely different type-species, remains a valid and available name. *Trachythyonidium* therefore becomes an objective junior synonym of *Euthyonidium*. Heding and Panning (1954) have referred *Euthyonidium seguroensis* to *Duasmodactyla* Ayres, 1852.

Thyone crassidisca Pawson and Miller, 1981

Figures 29, 30

Thyone crassidisca Pawson and Miller, 1981, p. 400, figs. 1, 2B, 4.

Material examined: HOURGLASS STATION I: 1 (PARATYPE), 16 mm; 9 March 1966; dredge; FSBC I 24000. — 4 (PARATYPES), 28-41 mm; 4 September 1966; trawl; USNM E 21114. — FEDERAL CLAM: 1 (PARATYPE), 59 mm; 23 August 1971; hydraulic dredge; 25°43.9'N, 81°42.2'W; 6.1 m; IRCZM 71:117.

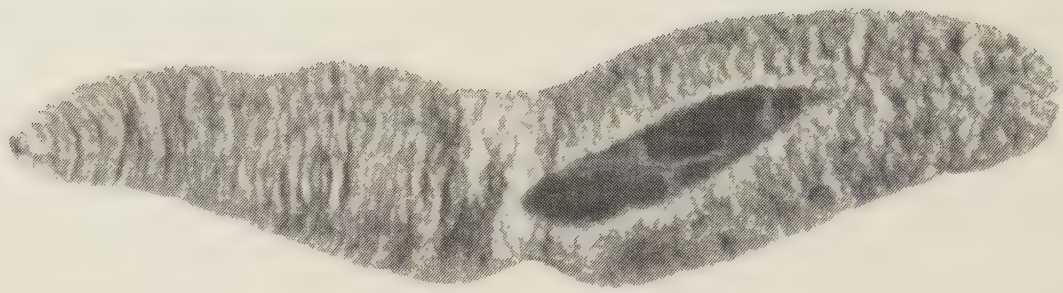

Figure 29. *Thyone crassidisca* Pawson and Miller, USNM E 21113, holotype, off New Smyrna Beach, Florida, 51 mm TL, dorsal view.

Diagnosis: Small form, up to 60 mm. Body fusiform, tapering toward bluntly rounded ends. Podia numerous, scattered over entire body; strongly contracted in preserved specimens. Tentacles 10, ventral pair smaller. Body wall tables with 4 perforations and spire terminating in single blunt spine. Coloration in preserved specimens whitish to light brown, with scattered patches of light to dark brown.

Ossicles: Body wall — Numerous tables; disc, 70-110 μm long; spire, 60-100 μm high; disc oval with 4 perforations, with thick, strongly knobbed margin; spire robust, greatly tapering to blunt tip; conspicuous "handle" or half ring opposite spire on inner surface of disc. Podia — Numerous supporting tables; disc 100-165 μm long; spire 55-105 μm high; disc curved, elongate, with 4 central

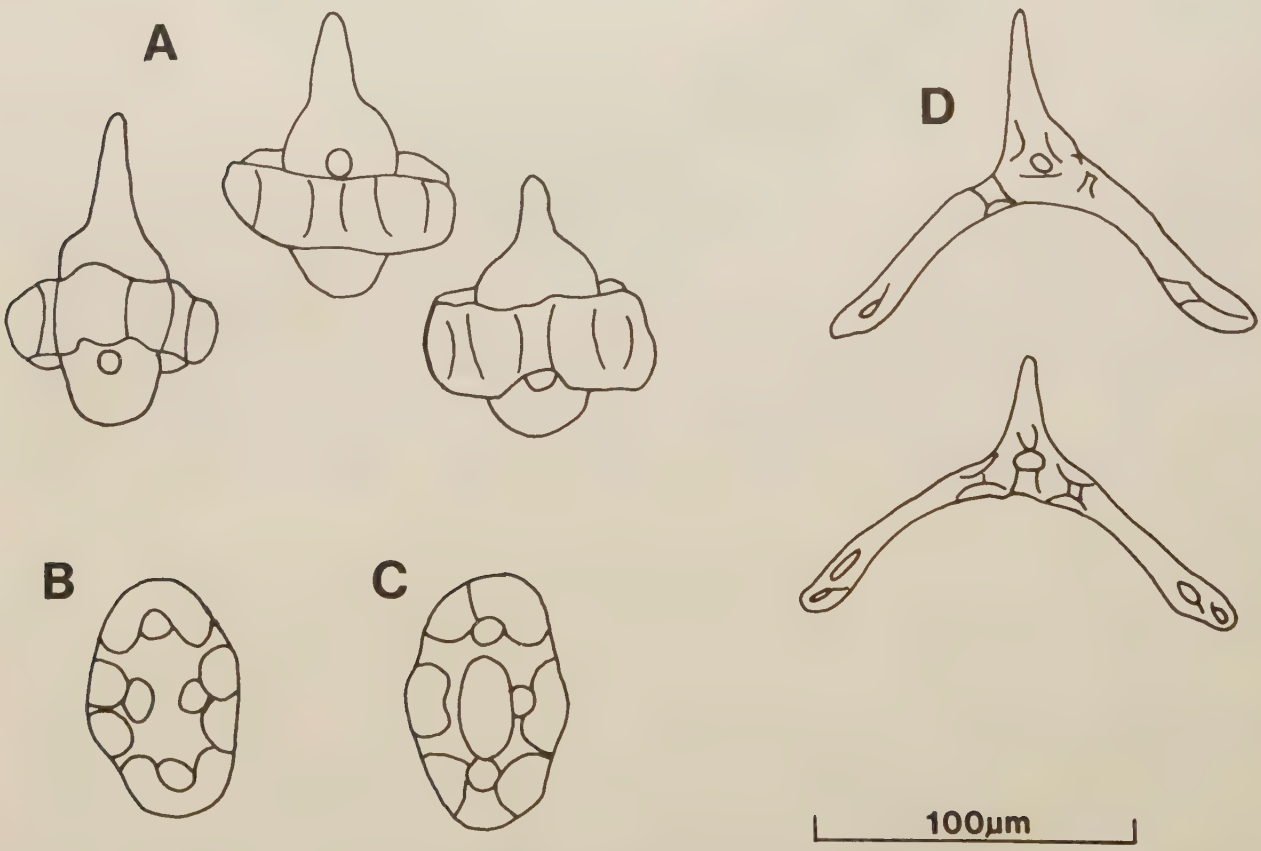

Figure 30. *Thyone crassidisca* Pawson and Miller, skeletal ossicles. A. tables from body wall, lateral view; B. same, dorsal view; C. same, ventral view; D. supporting tables from podia.

and 1-2 terminal perforations; spire high, greatly tapering to blunt or acute terminus; end plate present.

Type-specimen: National Museum of Natural History, Smithsonian Institution, USNM E 21113.

Type-locality: R/V *Gosnold* Cruise 243, Station 621, off east-central Florida, 28° 58.8′N, 79° 58.8′W, 27 m.

Distribution: Presently known only from the type-locality and the west coast of Florida. Hourglass specimens were taken exclusively at Station I (Figure 31). Bathymetric range, 6-45 m.

Bottom type: Sediments at Station I were composed of quartz sand and crushed shell with a fine layer of silt.

Gear selectivity: Four Hourglass specimens were collected in the trawl versus one specimen in the dredge.

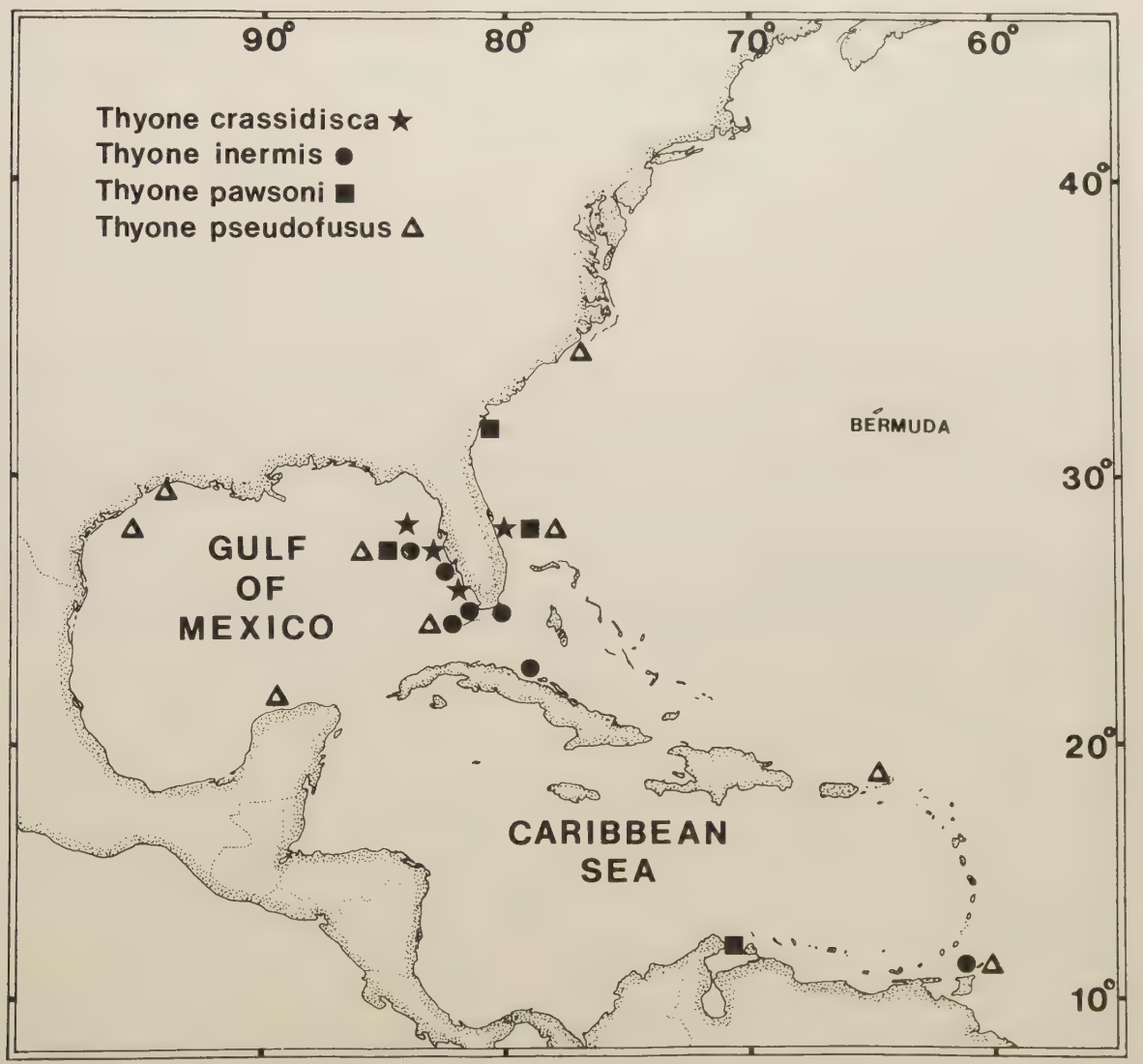

Figure 31. Geographic distributions of *Thyone crassidisca*, *T. inermis*, *T. pawsoni* and *T. pseudofusus* in the northwestern Atlantic and the Gulf of Mexico.

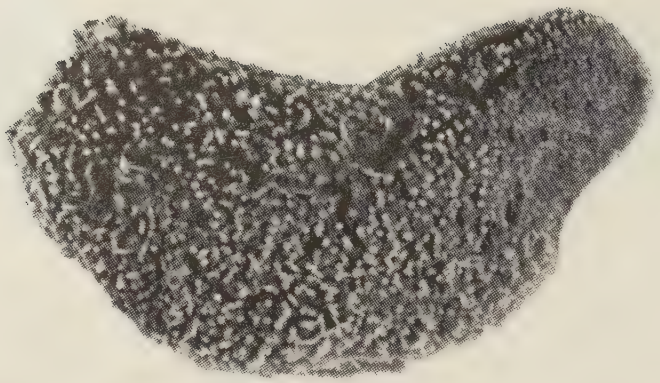

Figure 32. *Thyone inermis* Heller, IRCZM 71:142, southwest of Pavilion Key, Florida, 16 mm TL, lateral view.

Thyone inermis Heller, 1868

Figures 32, 33

Thyone inermis Heller, 1868, p. 78; Deichmann, 1946, p. 3; 1947, p. 87, pl. 1, figs. 7-13, pl. 2, figs. 1-17; Panning, 1949, p. 468; Deichmann, 1954, p. 397; Pawson and Miller, 1981, pp. 394, 395.

Thyone fusus: Deichmann, 1930, p. 167, pl. 14, figs. 1-5; Domantay, 1959, p. 196.

Thyone deichmannae Madsen, 1941, p. 26.

Havelockia inermis: Panning, 1949, p. 466.

Not: *Thyone fusus* (Müller, 1776).

Material examined: HOURGLASS STATION C: 1, 40 mm; 6 November 1966; dredge; FSBC I 24427. — 1, 30 mm; 11 May 1967; trawl; FSBC I 24428. — HOURGLASS STATION I: 1, 42 mm; 12 June 1966; trawl; USNM E 22338. — FEDERAL CLAM: 1, 16 mm; 22 August 1971; hydraulic dredge; 25°34.8′N, 81°38.3′W; 7.6 m; IRCZM 71:142. — SHRIMP DISCARD: 1, 37 mm; 8-11 May 1978; 2-seam balloon trawl; 24°47′N, 81°49′W to 24°51′N, 81°53′W; 14.6-15.2 m; FSBC I 24429.

Diagnosis: Medium-size, burrowing form, up to 120 mm. Body cylindrical, covered with numerous hair-like podia arranged in indistinct double rows along radii, scattered in interradii. Tentacles 10, ventral pair smaller. Ossicles consisting of tables; many body wall tables with more than 4 perforations; spire of supporting tables gently tapering. Coloration in preserved specimens greyish brown.

Ossicles: Body wall — Tables with squarish to rectangular disc, 65-135 μm diameter, with 4 to 18 perforations; spire tall, 80-115 μm, composed of 2 pillars, gently tapering to end in 1 or 2 teeth. Podia — Elongate, curved supporting tables, 110-180 μm long, 70-120 μm high; end plates well developed.

Type-specimen: Unknown.

Type-locality: Lesina (Hvar Island), Yugoslavia.

Distribution: In the western Atlantic, reported from Florida, Cuba, and Tobago (Figure 31). Hourglass specimens, representing the northernmost specimens collected to date, were taken at Stations C and I. Bathymetric range 8-366 m. Also occurs in the Mediterranean and around Portugal, the Azores and north to Roscoff, France.

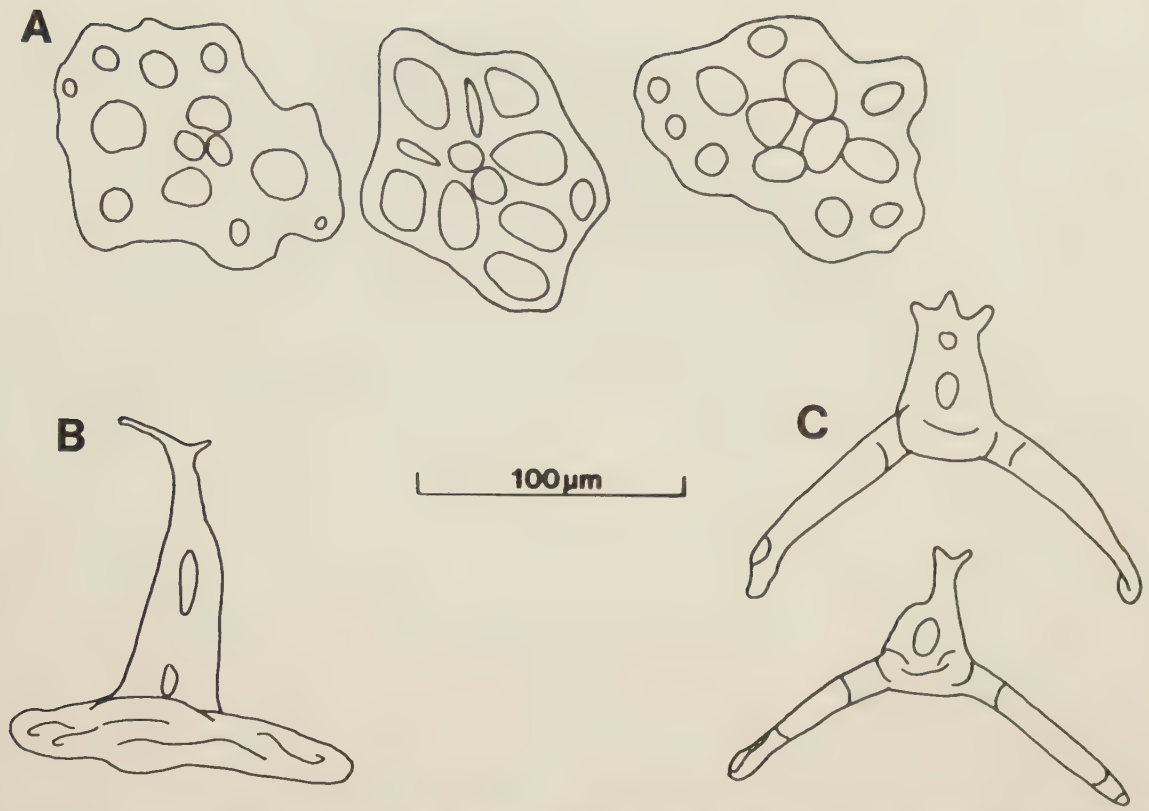

Figure 33. *Thyone inermis* Heller, skeletal ossicles. A. tables from body wall, dorsal view; B. same, lateral view; C. supporting tables from podia.

Bottom type: Sediments at Station C consisted of crushed shell and other organically-derived calcium particles covered with a heavy layer of white calcareous silt. At Station I, sediments were composed of quartz sand and crushed shell.

Diet: Gut analysis revealed 80% calcareous remains including forams, molluscan shell fragments, ostracod valves, and echinoid spines, 15% amorphous material, and 5% diatom remains. Although a member of the order Dendrochirotida, characterized by having dendritic tentacles for capturing planktonic prey, this species appears to utilize bottom sediments for the bulk of its nutritional requirements.

Remarks: Including the Hourglass material, only 14 specimens of *T. inermis* have been recorded from the western Atlantic. According to Deichmann (1947; 1954), no sexually mature specimens of this amphi-Atlantic species were known from the western Atlantic. From this, Deichmann suggested that *T. inermis* was unable to establish populations in the western Atlantic, and that recruitment to this region most likely succeeded through larval dispersal from eastern Atlantic populations.

Examination of the gonads from Hourglass material revealed that mature eggs and sperm occur in specimens with total lengths of 16-42 mm (Deichmann examined specimens up to 70 mm TL). The large, lecithotrophic eggs indicate a direct form of development, characteristic of species in the order Dendrochirotida. The record of these mature specimens from the Gulf of Mexico provides empirical evidence for established populations of *T. inermis* in the western Atlantic.

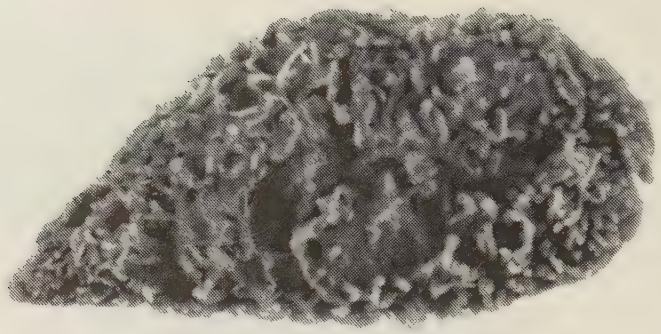

Figure 34. *Thyone pawsoni* Tommasi, IRCZM 71:112, off Georgia, 24 mm TL, lateral view.

Thyone pawsoni Tommasi, 1972

Figures 34, 35

Thyone pawsoni Tommasi, 1972, p. 19, figs. 12-15; Pawson and Miller, 1981, p. 397, figs. 2D, 2E.

Material examined: HOURGLASS STATION A: 1, 14 mm; 2 June 1967; dredge; FSBC I 24450. — HOURGLASS STATION C: 1, 13 mm; 7 February 1966; dredge; USNM E 22334.

Diagnosis: Small, burrowing form, 10-60 mm, tapering abruptly posteriorly to form short tail. Body completely covered with numerous, cylindrical tube feet. Radii indistinct. Tentacles 10, ventral pair smaller. Ossicles consisting of tables; many body wall tables with more than 4 perforations; spire of supporting tables abruptly tapering. Coloration in preserved specimens tan or brown.

Ossicles: Body wall — Numerous tables with square to oval disc, 85-135 μm long, 65-100 μm wide, containing 4-9 perforations, with thin margin; spire high, 60-85 μm, tapering to terminate in 3 teeth; occasionally a "handle" or half-ring located opposite spire. Podia — Elongate, curved supporting tables with high, abruptly tapering spire, 105-130 μm long, 90-130 μm high.

Type-specimen: Original description based on syntypic series of three specimens, total lengths 29-56 mm. Deposition of type material unknown.

Type-locality: Gulf of Venezuela, *Oregon* Station 5679, 12°20′N, 71°00′W; 44 m.

Distribution: Previously known only from the type-locality. One of us (JEM) has examined specimens from off east-central Florida and South Carolina. The two Hourglass specimens, taken at Stations A and C, represent the first record of *T. pawsoni* in the Gulf of Mexico (Figure 31). Bathymetric range, 6-51 m.

Bottom type: Sediments at Station A were characterized by quartz sand and crushed shell covered with a fine layer of silt. Station C sediments consisted of crushed shell and other organically derived calcium particles covered with a heavy layer of white calcareous silt.

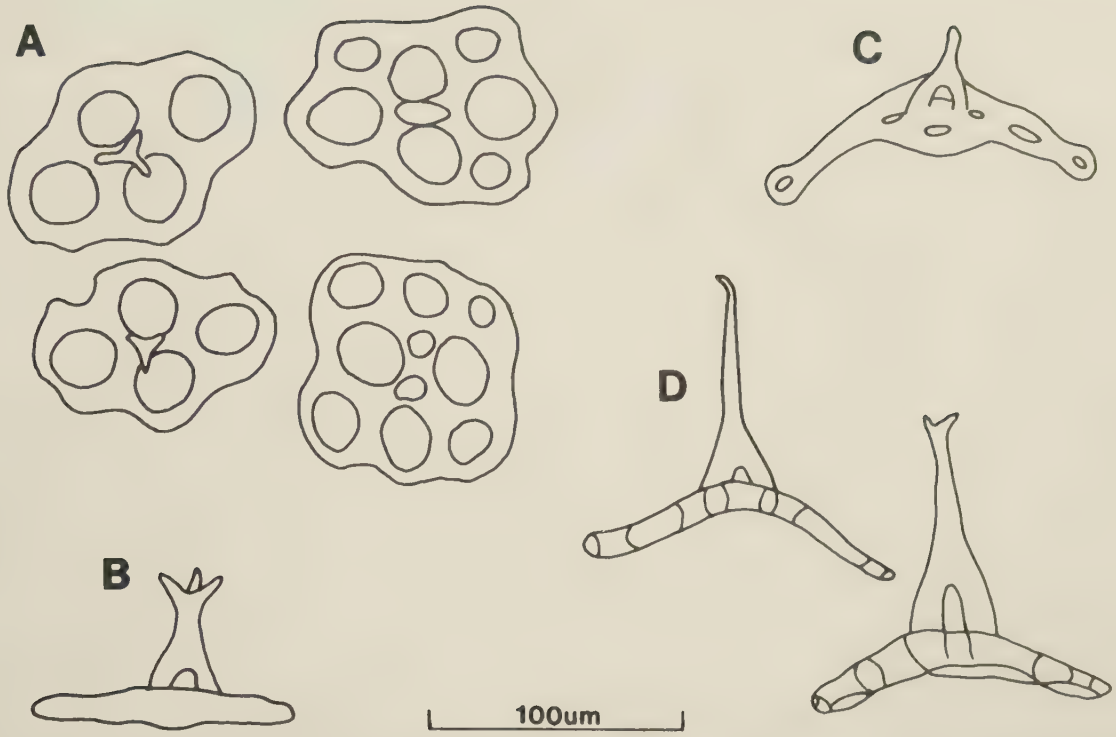

Figure 35. *Thyone pawsoni* Tommasi, skeletal ossicles. A. tables from body wall, dorsal view; B. same, lateral view; C. supporting table from podia, dorsal view; D. same, lateral view.

Remarks: Tommasi (1972) described *T. pawsoni* from material 29-56 mm in total length. In specimens of this size, the body wall tables apparently have an oval disc with only 4 perforations. Lengths of material we examined during this study and from other localities were less than 25 mm. In these smaller specimens, a number of square-shaped tables with more than 4 perforations were found.

Thyone pseudofusus Deichmann, 1930

Figures 36, 37

Thyone pseudofusus Deichmann, 1930, p. 168, pl. 14, figs. 6-9; H. L. Clark, 1933, p. 114; Deichmann, 1941, p. 107; 1946, p. 4; Panning, 1949, p. 467; Deichmann, 1954, p. 395; Domantay, 1959, p. 197; Tommasi, 1969, p. 12, fig. 14; Harry, 1979, p. 41; Pawson and Miller, 1981, pp. 395, fig. 2C.

Material examined: HOURGLASS STATION B: 2, 13, 15 mm; 5 February 1967; dredge; USNM E 22328. — 1, 17 mm; 2 March 1967; trawl; IRCZM 71:147. — 1, 8 mm; 20 May 1967; dredge; FSBC I 24497. — 1, 10 mm; 20 November 1967; trawl; FSBC I 24498. — HOURGLASS STATION C: 1, 8 mm; 19 November 1965; trawl; FSBC I 24499. — 1, 12 mm; 3 December 1965; dredge; FSBC I 24500. — 3, 8-14 mm; 7 February 1966; dredge; FSBC I 24501. — 1, 9 mm; 8 September 1966; trawl; FSBC I 24502. — 1, 11 mm; 6 November 1966; dredge; FSBC I 24518. — 1, 15 mm; 13 December 1966; trawl; FSBC I 24503. — 2, 9, 11 mm; 13 December 1966; dredge; FSBC I 24504. — 3, 10-12

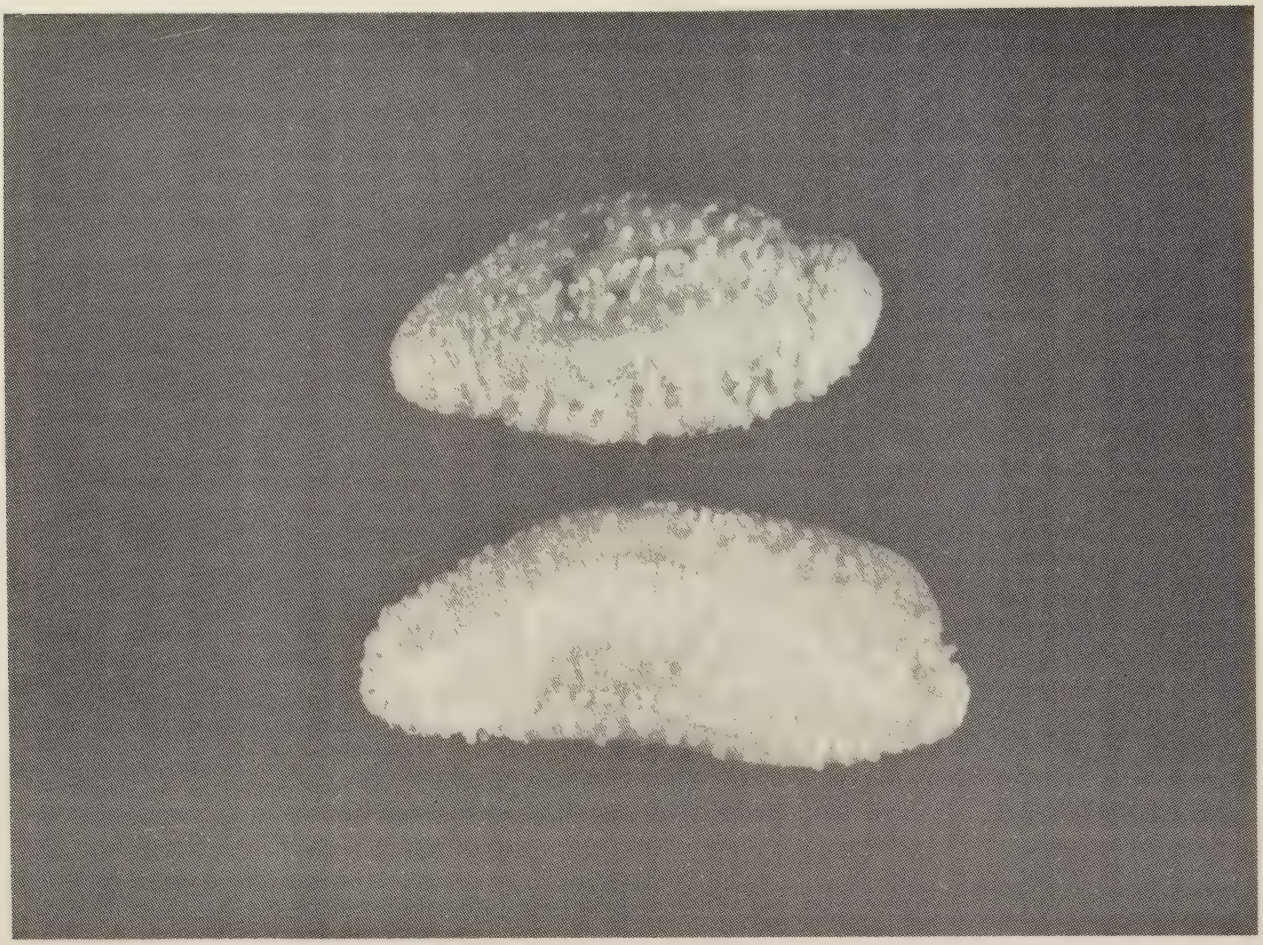

Figure 36. *Thyone pseudofusus* Deichmann, USNM E 2665, syntypes, off Yucatan, 11 mm TL (top), 13 mm TL (bottom), lateral view.

mm; 20 January 1967; dredge; FSBC I 24505. — 4, 8-17 mm; 5 February 1967; dredge; FSBC I 24506. — 2, 9, 14 mm; 2 March 1967; dredge; FSBC I 24507. — 1, 19 mm; 3 April 1967; dredge; FSBC I 24508.

Diagnosis: Small, burrowing form, up to 20 mm. Body tapering, with mouth and anus directed dorsally. Podia in double rows along radii, scattered on interradii, especially ventrally. Tentacles 10, ventral pair smaller. Body wall tables with 4 perforations, and spire terminating in several teeth. Coloration in preserved specimens white to grey.

Ossicles: Body wall — Oval tables with thick disc, 4 perforations; spire robust, terminating in several small teeth, frequently arranged in 2 adjacent whorls; distinct "handle" or half-ring opposite spire on inner surface of disc; tables 105-140 μm long, 60-85 μm wide, 65-85 μm high. Podia — Elongate, curved supporting tables, 100-125 μm long, 70-110 μm high, with 2- or 3-pillar spires ending in a few teeth; end plate well developed.

Type-specimen: No holotype designated; type lot, 18 specimens, National Museum of Natural History, Smithsonian Institution, USNM E 2665.

Type-locality: Yucatan, *Albatross* Station 2362, 22°08′30″N, 86°53′30″W, 46 m.

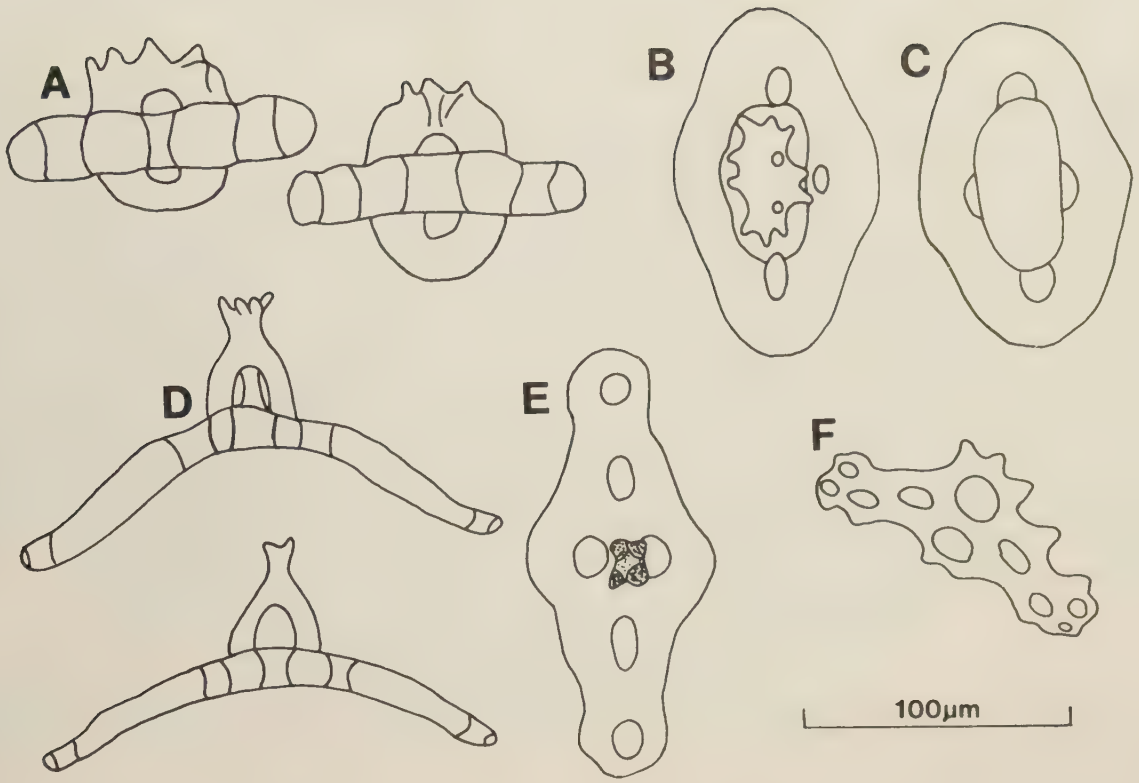

Figure 37. *Thyone pseudofusus* Deichmann, skeletal ossicles. A. body wall tables, lateral view; B. same, dorsal view; C. same, ventral view; D. supporting tables from podia, lateral view; E. same dorsal view; F. plate from distal portion of podia.

Distribution: Previously known from Dry Tortugas, Texas, Yucatan, British West Indies, Tobago, and Brazil (Figure 31). Hourglass specimens, representing the first record in the eastern Gulf of Mexico, were taken at Stations B and C (Table 7). One of us (JEM) has examined specimens from Ft. Pierce, Florida, and Cape Lookout, North Carolina (northern range extension). Bathymetric range, 6-46 m.

Bottom type: Sediments at Station B consisted of shell and quartz sand covered with the green alga, *Caulerpa*, and the sea grass, *Halophila*. Station C was characterized by crushed shell and other organically derived calcium particles covered with a dense layer of white calcareous silt.

Diet: Examination of gut contents from specimens taken at Station C revealed 95% calcareous remains (unidentifiable) and 5% quartz sand. Although a member of the predominantly plankton feeding order Dendrochirotida, gut contents revealed that *T. pseudofusus* is capable of deposit feeding.

Seasonality: Of the 25 specimens collected over the two-year period, only three individuals were taken during the months of April through October (Table 7).

Gear selectivity: Twenty specimens were taken by dredge, 5 by trawl.

TABLE 7. NUMBERS OF *Thyone pseudofusus* COLLECTED DURING PROJECT HOURGLASS, BY STATION AND MONTH.

Thyone pseudofusus

STA	1965					1966													1967											TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A																															
B_1																					2	1									3
B_2																								1						1	2
C_1					1		3										1				4	2	1								12
C_2				1											1			3	3												8
D_1																															
D_2																															
E																															
I																															
J																															
K																															
L																															
M																															
TOT				1	1		3								1		1	3	3		6	3	1	1						1	25

Subscripts 1, 2 and sp designate regular, post and supplementary cruises.

Family Psolidae Perrier, 1902

Diagnosis: Body flattened, with well-defined soft ventral sole surrounded by tube feet; ossicles large, conspicuous; dorsal surface with imbricating scale-like plates; mouth and anus directed dorsally.

Psolus tuberculosus Théel, 1886

Figures 38, 39

Psolus tuberculosus Théel, 1886b, p. 13, fig. 5; Deichmann, 1930, p. 186, pl. 20, fig. 3; 1954, p. 401.

Material examined: HOURGLASS STATION E: 4, 15-21 mm; 7 June 1966; dredge; IRCZM 71:138. — 1, 15 mm; 3 July 1966; trawl; FSBC I 24397. — 1, 21 mm; 3 March 1967; trawl; FSBC I 24398. — 1, 20 mm; 3 November 1967; trawl; FSBC I 24399. — 1, 13 mm; 3 November 1967; dredge; FSBC I 24400. — HOURGLASS STATION M: 2, 11, 22 mm; 13 November 1966; dredge; USNM E 22331. — 1, 7 mm; 5 September 1967; trawl; FSBC I 24401. — 1, 12 mm; 15 November 1967; dredge; FSBC I 24402.

Diagnosis: Small form, 10-33 mm long. Body flattened ventrally, forming distinctly recessed sole, bordered by double ring of tube feet. Body wall rigid dorsally, invested with heavy imbricating plates, many possessing distinct tubercle or blunt spine. Mouth dorsal, concealed by 5 large valves. Anus dorsal, bordered by 2 circles of small scales. Ossicles of sole consisting of perforated plates. Coloration in living specimens bright orange, turning yellowish brown to white in alcohol.

Ossicles: Sole — Large perforated plates, 130-260 μm diameter, with knobbed surface occasionally forming secondary network.

Type-specimen: Museum of Comparative Zoology, Harvard University, Cambridge, Mass., MCZ 337.

Type-locality: Sand Key, Florida.

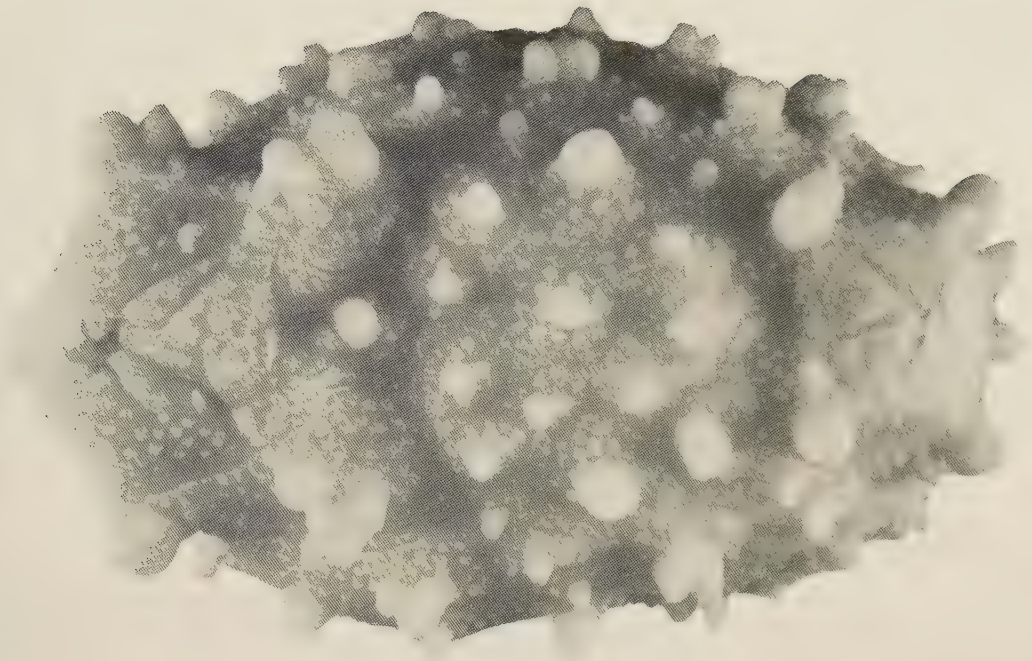

Figure 38. *Psolus tuberculosus* Théel, IRCZM 71:138, Hourglass Station E, 20 mm TL, dorsal view.

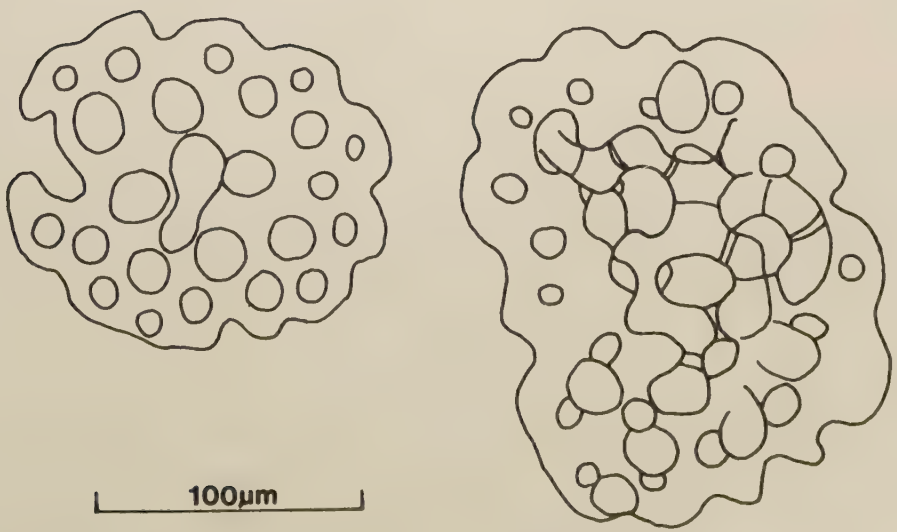

Figure 39. *Psolus tuberculosus* Théel, skeletal ossicles, perforated plates from sole.

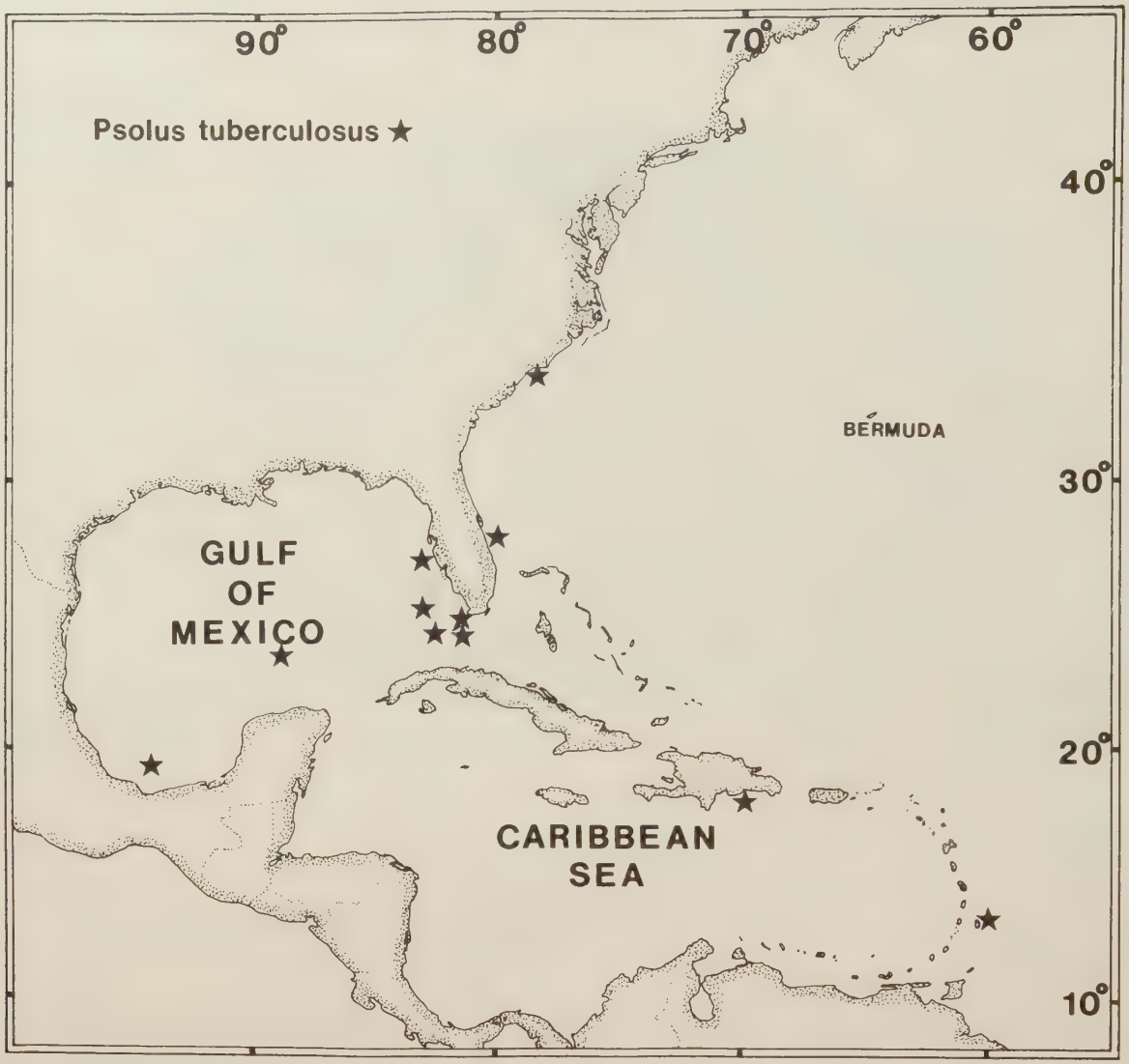

Figure 40. Geographic distribution of *Psolus tuberculosus* in the northwestern Atlantic and the Gulf of Mexico.

Distribution: East Florida off Ft. Pierce, Gulf of Mexico, Campeche Bank, Mexico, Dominican Republic and Barbados; 73-243 m (Figure 40). One of us (JEM) has examined specimens from South Carolina, 96-98 m, the northernmost record of this species. Hourglass specimens taken at Stations E and M (Table 8) demark the shallow limit of the depth range.

Diet: Gut analysis of specimens from Station E revealed 80-90% amorphous material and 10% sponge spicules, diatoms, forams and serpulid worm tubes. Although *P. turberculosus*, as a dendrochirotid, is considered a suspension feeder, the presence of benthic material in the gut suggests that at least part of its food is acquired by deposit feeding.

Gear selectivity: Eight specimens were taken by the dredge, 4 by the trawl.

TABLE 8. NUMBERS OF *Psolus tuberculosus* COLLECTED DURING PROJECT HOURGLASS, BY STATION AND MONTH.

Psolus tuberculosus																													
STA	1965					1966													1967										TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A																															
B_1																															
B_2																															
C_1																															
C_2																															
D_1																															
D_2																															
E											4	1										1							2	8
I																															
J																															
K																															
L																															
M																	2											1	1	4	
TOT											4	1					2					1						1	3	12	

Subscripts 1, 2 and sp designate regular, post and supplementary cruises.

ORDER ASPIDOCHIROTIDA GRUBE, 1840

Diagnosis: Introvert and retractor muscle absent. Tube feet and respiratory trees well developed. Tentacles 10-30, shield-shaped. Body with conspicuous external bilateral symmetry. Mesentery of posterior loop of intestine attached to right ventral interradius. Ossicles usually include tables.

Remarks: Twenty-three species of the order Aspidochirotida are known to occur in the Gulf of Mexico (Table 2). Only four of these species were taken during Project Hourglass. One additional species was collected during the Federal Clam Project.

KEY TO ASPIDOCHIROTIDA OF THE GULF OF MEXICO

1. Tentacle ampullae present; mostly shallow water forms 2
1. Tentacle ampullae absent; deep water forms 18
2. Gonad divided into 2 tufts, one on either side of dorsal mesentery 3
2. Gonad as single tuft on left side of dorsal mesentery 5
3. Ossicles small C-, O- or S-shaped bodies scattered among numerous minute granules; tables absent ..... *Astichopus multifidus* (Sluiter, 1910)
3. Ossicles include tables; C-shaped bodies present or absent 4
4. Ossicles tables with single ring of perforations on disc; C-shaped bodies present ..... *Isostichopus badionotus* (Selenka, 1867)
4. Ossicles tables with several rings of perforations on disc; C-shaped bodies absent ..... *Eostichopus regalis* (Cuvier, 1817)
5. Calcified anal teeth present ..... *Actinopyga agassizii* (Selenka, 1867)
5. Calcified anal teeth absent 6
6. Ossicles exclusively straight to curved rods with branched ends ..... *Holothuria* (*Selenkothuria*) *glaberrima* Selenka, 1867

6. Ossicles not exclusively rods 7

7. Ossicles tables with reduced disc; large, flat rods with dentate margins; no rosettes, buttons or perforated plates ..... *Holothuria* (*Semperothuria*) *surinamensis* Ludwig, 1875

7. Ossicles tables in combination with rosettes, buttons or perforated plates; rods may also be present 8

8. Ossicles small tables with high spire terminating in 12 teeth; numerous rosettes or perforated plates; no buttons 9

8. Ossicles variable tables and buttons; no rosettes; perforated plates may be present in papillae 11

9. Ossicles scattered tables (50-60 μm height); small rosettes (20-30 μm diameter) ..... *Holothuria* (*Halodeima*) *floridana* Pourtalès, 1851

9. Ossicles tables and perforated plates 10

10. Ossicles scattered tables (60-70 μm height) often with 2 or more distinct spines on disc margin; perforated rectangular plates (50-80 μm long) with dentate margin and 2-4 large, central perforations surrounded by several smaller perforations at each end ..... *Holothuria* (*Halodeima*) *grisea* Selenka, 1867

10. Ossicles tables (50-60 μm height) lacking spines on disc margin; perforated plates biscuit-shaped (30-50 μm diameter) with minute perforations ..... *Holothuria* (*Halodeima*) *mexicana* Ludwig, 1875

11. Deep water forms commonly occurring at depth greater than 60 m 12

11. Shallow water forms commonly occurring intertidally or at depths of less than 30 m 13

12. Ossicles irregular smooth buttons; tables with tall spire terminating in 9-12 short teeth; dorsally 2 rows of conspicuous, dark brown blotches ..... *Holothuria* (*Vaneyothuria*) *lentiginosa enodis* Miller and Pawson, 1979

12. Ossicles irregular knobbed bottons, often twisted; tables with reduced spire terminating in 4 blunt teeth; dorsally lacking dark brown blotches ..... *Holothuria* (*Cystipus*) *occidentalis* Ludwig, 1875

13. Flattened form; ossicles tables; buttons with alternating perforations ..... *Holothuria* (*Platyperona*) *parvula* (Selenka, 1867)

13. Cylindrical forms; ossicles tables; buttons with paired perforations 14

14. Ossicles tables with 20-25 marginal perforations; buttons with thickened margin forming conspicuous scalloped ridge ..... *Holothuria* (*Platyperona*) *rowei* Pawson and Gust, 1981

14. Ossicles tables with 4-12 marginal perforations; buttons with smooth to knobbed margin 15

15. Buttons smooth; Curvierian organs present 16

15. Buttons knobbed; Cuvierian organs absent 17

16. Medium-size burrowing form, TL less than 15 cm; ossicles in dorsal appendages rods ..... *Holothuria* (*Thymiosycia*) *arenicola* Semper, 1868

16. Large reef-dwelling form, TL up to 200 cm; ossicles in dorsal appendages perforated plates ..... *Holothuria* (*Thymiosycia*) *thomasi* Pawson and Caycedo, 1980

17. Dorsally 2 rows of conspicuous, dark brown blotches; tables similar to body wall tables present in dorsal papillae ..... *Holothuria* (*Holothuria*) *dakarensis* Panning, 1939

17. Conspicuous brown blotches absent; enormous "tack-like" tables (200-300 μm height) usually present in dorsal papillae ..... *Holothuria* (*Theelothuria*) *princeps* Selenka, 1867

18. Ossicles few; anus sunken in vertical furrow ..... *Pseudostichopus occultatus* von Marenzeller, 1893

18. Ossicles numerous; anus not sunken in vertical furrow 19

19. Ossicles tables with cross-shaped discs ..... *Bathyplotes natans* (Sars, 1868)

19. Ossicles tables with circular discs 20

20. Papillae and tube feet large, distinctly arranged in regular radii ..... *Amphigymnas bahamensis* Deichmann, 1930

20. Papillae and tube feet small, scattered 21

21. Tube feet few, present as warts in ventrolateral radii only ... *Mesothuria lactea* (Théel, 1886)

21. Tube feet numerous, thread-like 22

22. Ossicles tables with triradiate spires ..... *Mesothuria maroccana* Perrier, 1902

22. Ossicles tables with quadriradiate spires ..... *Mesothuria verrilli* (Théel, 1886)

Family Stichopodidae Haeckel, 1896

Diagnosis: Gonad in two tufts, one on either side of dorsal mesentery; tentacle ampullae present.

Astichopus multifidus (Sluiter, 1910)

Figures 41, 42

Stichopus multifidus Sluiter, 1910, p. 334, figs. a, b.

Astichopus multifidus: H. L. Clark, 1922, p. 48; Deichmann, 1930, p. 84, pl. 5, figs. 44-47; H. L. Clark, 1933, p. 110; Deichmann, 1939, p. 132; Cherbonnier, 1949a, p. 162, pl. 2, figs. 1-25; Deichmann, 1954, p. 388; 1963, p. 106; Glynn, 1965, p. 106, figs. 1-4; Levin and Gomes, 1975, p. 56; Caycedo, 1978, p. 183, pl. 13, figs. 1-7, pl. XI, figs. a, b.

Material examined: HOURGLASS STATION K: 2, 155, 240 mm; 4 September 1965; trawl; IRCZM 71:144. — 1, 200 mm; 11-12 October 1967; trawl; FSBC I 24451. — SHRIMP DISCARD: 1, 145 mm; 8-11 May 1978; 2-seam balloon trawl; 24°47-51'N, 81°49-53'W; 14.6-15.2 m; USNM E 22327.

Diagnosis: Large, cylindrical species, up to 450 mm in life, much contracted in preserved condition. Ventral surface flattened, covered with dense layer of cylindrical podia. Dorsally, podia papillate, numerous, scattered. Body wall soft, thick. Ossicles small, scattered, consisting of C-, O- or S-shaped bodies. Coloration in life variable, dorsally variegated brownish yellow, ventrally white and pale pink podia and scattered black flecking.

Ossicles: Scattered C-, O- or S-shaped bodies, 15-40 μm long; miliary grains very numerous, irregular to spherical, 3-6 μm diameter.

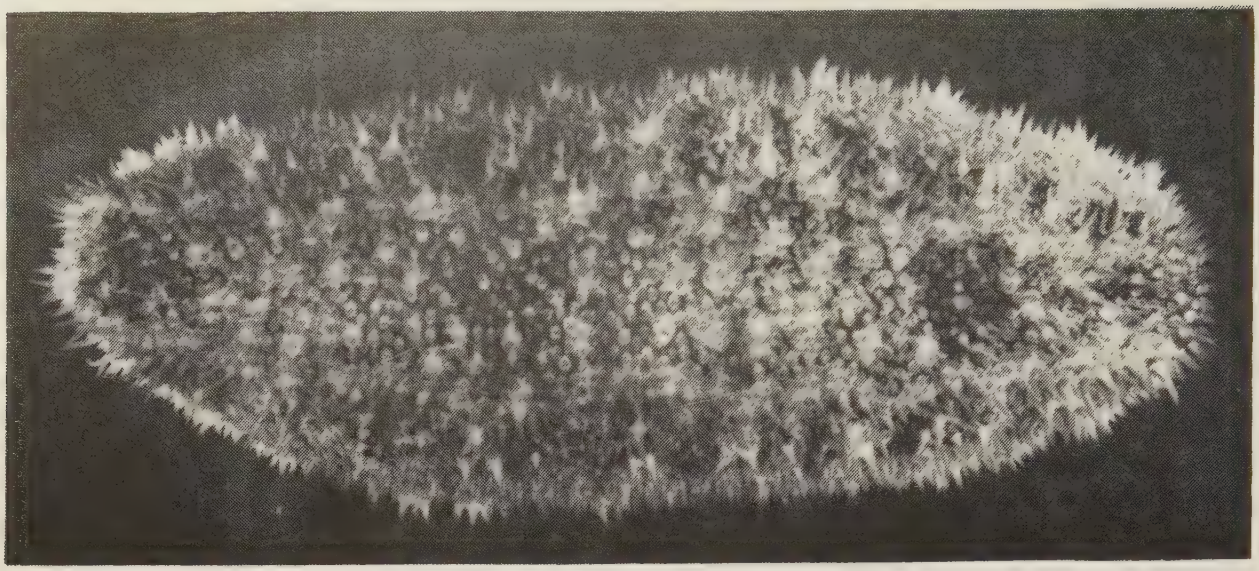

Figure 41. *Astichopus multifidus* (Sluiter), La Parguera, Puerto Rico, 300 mm TL, dorsal view.

Type-specimen: Hamburg Museum, West Germany, according to Deichmann (1954).

Type-locality: Dry Tortugas, Florida.

Distribution: Previously reported from Biscayne Bay, Florida, Dry Tortugas, Bahia de Campeche, Mexico, Cuba, Jamaica, Puerto Rico, Colombia, and Venezuela (Figure 43). Hourglass specimens were taken exclusively at Station K and represent the first record of *A. multifidus* in the eastern Gulf. One of us (JEM) has found this species off West End, Grand Bahama Island, the first Bahamas record and the northernmost record of the species. Bathymetric range 1-37 m.

Bottom type: Bottom habitat for *A. multifidus* varies, although substrates with a layer of marine

Figure 42. *Astichopus multifidus* (Sluiter), skeletal ossicles, variously shaped bodies from body wall.

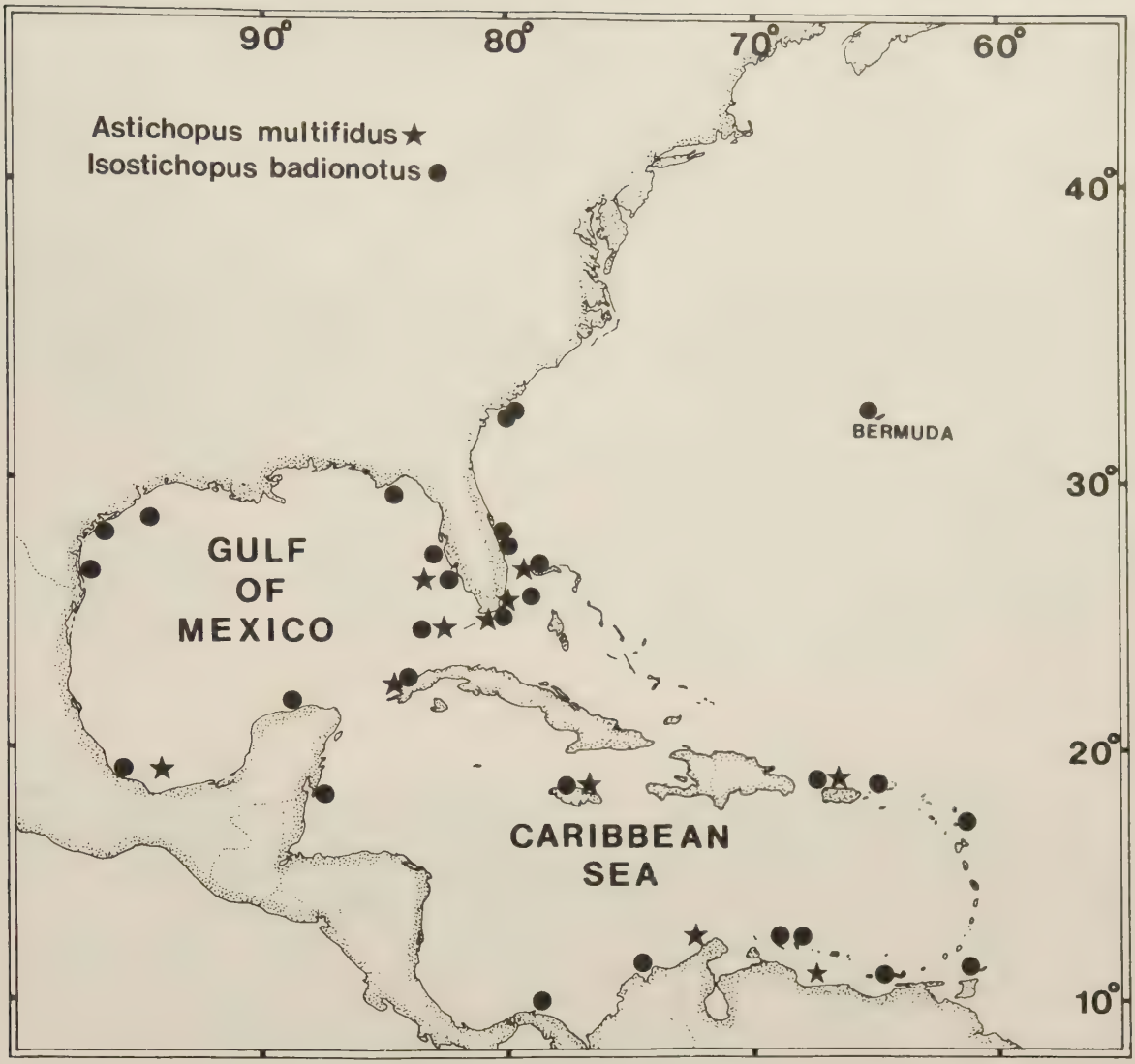

Figure 43. Geographic distributions of *Astichopus multifidus* and *Isostichopus badionotus* in the northwestern Atlantic and the Gulf of Mexico. Locality marker for *A. multifidus* off Venezuela uncertain. Cherbonnier, 1949b. Coast of Venezuela.

vegetation are preferred (H. L. Clark, 1933; Deichmann, 1939; Glynn, 1965; Caycedo, 1978). Hourglass specimens were taken from a bottom composed of crushed shell covered with white calcareous silt; calcareous algae were also noted. The two specimens collected during the Federal Clam Project were from a white mud substratum.

Diet: Examination of gut contents revealed >95% calcareous sediment including bivalves, gastropods, scaphopods, forams, hard corals, bryozoans, echinoid plates and spines. No organic matter was apparent. Siliceous sand accounted for less than 5% of the total content.

Behavior: A study of the active movements, both naturally and artificially stimulated, was investigated by Glynn (1965), who documented swimming movements in adult *A. multifidus*.

Symbiotic associations: Caycedo (1978), working with *A. multifidus* from Bahia de Nenguange, Colombia, reported several symbionts of the species. Concealed among the papillae, he found gastropods of the genus *Balcis*. Inhabiting the tentacles, dorsal surface and cloaca were the

porcellanid crab, *Porcellana sayana* (Leach). The pearlfish, *Carapus bermudensis* (Jones), was also reported as an inquiline of *A. multifidus*.

Isostichopus badionotus (Selenka, 1867)

Figures 44, 45

Stichopus badionotus Selenka, 1867, p. 316, pl. 18, fig. 20; Deichmann, 1930, p. 80, pl. 5, figs. 30-36; Boone, 1933, p. 152, pl. 98; H. L. Clark, 1933, p. 109; Engel, 1939, p. 11; Deichmann, 1940, p. 195; H. L. Clark, 1942, p. 386; Deichmann, 1954, p. 388, fig. 66 (1-8); Ancona Lopez, 1958, p. 11, figs. 25-33, 57, 58; Tommasi, 1957, p. 41, fig. 30a, pl. 4, figs. 3, 4; Cherbonnier, 1959, p. 440, fig. 10 (a-m), fig. 11 (a-g); Domantay, 1959, p. 190; Brito, 1960, p. 4; Tommasi, 1960, p. 603; Caso, 1961, p. 357; Brito, 1962, p. 4, pl. 2, fig. 6; Burke, 1974, p. 320, fig. 22; Cherbonnier, 1975, p. 631.

Stichopus moebii Semper, 1868, p. 246, pl. 7, fig. 11; Crozier, 1918, p. 379.

Stichopus macroparentheses H. L. Clark, 1922, p. 61, pl. 4, figs. 1-7; Deichmann, 1930, p. 82, pl. 5, figs. 37-43.

Stichopus macraparentheses: H. L. Clark, 1933, p. 110.

Isostichopus badionotus: Deichmann, 1958, p. 280; 1963, p. 106; Tikasingh, 1963, p. 86, figs. 23-25; Smith and Tyler, 1969, p. 207; Tommasi, 1969, p. 5, figs. 1-2; 1972, p. 18; Martínez de Rodríguez and Herminson, 1975, p. 189, pl. 1, figs. 1-3; Levin and Gomes, 1975, p. 55; Pawson, 1976, p. 373; 1978, p. 27, fig. 11 m; Caycedo, 1978, p. 159, pl. 1, figs. 1-4, pl. I, figs. a-d; Harry, 1979, p. 39, pl. 6, figs. 29-37; Sloan and von Bodungen, 1980, p. 257.

Isostichopus macroparentheses: Pawson, 1976, p. 374, fig. 1D.

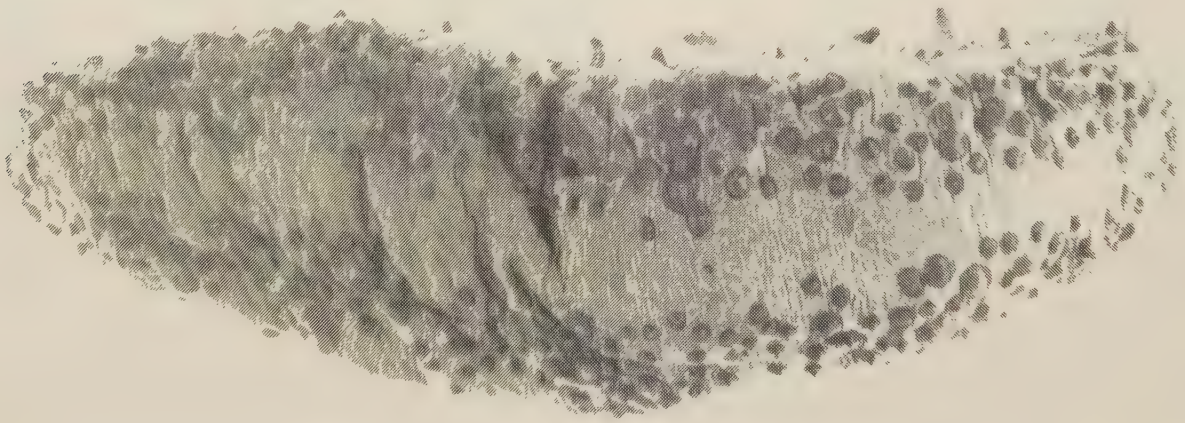

Figure 44. *Isostichopus badionotus* (Selenka), IRCZM 71:150, from Hobe Sound, Florida, 205 mm TL, dorsal view.

Material examined: HOURGLASS STATION B: 2, 100, 150 mm; 3 August 1965; trawl; FSBC I 24452. — 1, 130 mm; 26 August 1965; trawl; FSBC I 24453. — 2, 100, 100 mm; 30 August 1965; dredge; FSBC I 24455. — 1, 110 mm; 30 August 1965; trawl; FSBC I 24454. — 1, 42 mm; 6 November 1966; trawl; FSBC I 24456. — 1, 110 mm; 20 January 1967; dredge; FSBC I 24457. — 1, 40 mm; 2 March 1967; trawl; FSBC I 24458. — 1, 150 mm; 20 May 1967; dredge; FSBC I 24459. — 1, 170 mm; 20 June 1967; dredge; FSBC I 24460. — 2, 140, 155 mm; 1 July 1967; dredge; FSBC I 24462. — 1, 165 mm; 1 July 1967; trawl; FSBC I 24461. — 1, 140 mm; 11 July 1967; dredge; FSBC I 24464. — 2, 140, 220 mm; 11 July 1967; trawl; FSBC I 24463. — 1, 170 mm; 11 August 1967; trawl; FSBC I 24465. — 1, 160 mm; 31 August 1967; trawl; FSBC I 24466. — 2, 160, 180 mm; 5 October 1967; dredge; FSBC I 24467. — 1, 170 mm; 20 November 1967; dredge; FSBC I 24469. — 1, 139 mm; 20 November 1967; trawl; FSBC I 24468. — HOURGLASS STATION C: 2, 125, 170 mm; 31 August 1965; trawl; FSBC I 24470. — 1, 190 mm; 20 May 1967; dredge; FSBC I 24472. — 1, 185 mm; 20 May 1967; trawl; FSBC I 24471. — 1, 180 mm; 2 June 1967; trawl; FSBC I 24473. — 1, 30 mm; 11

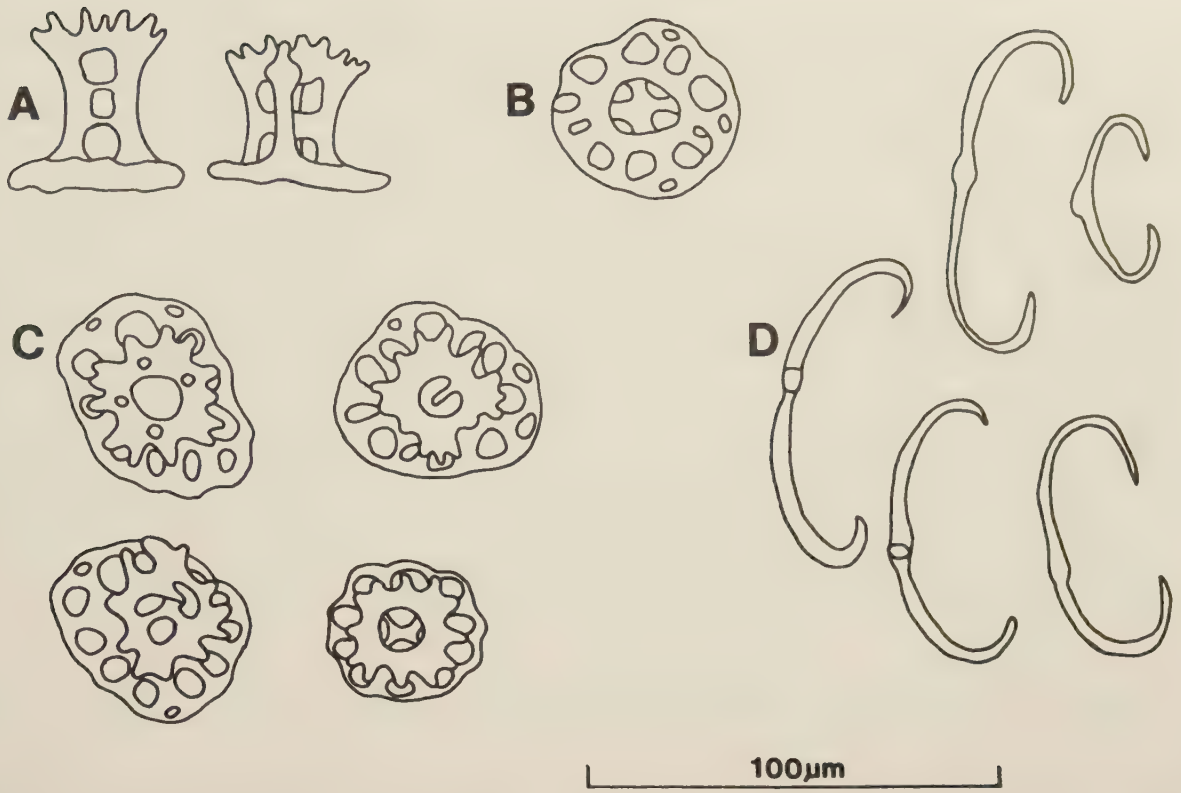

Figure 45. *Isostichopus badionotus* (Selenka), skeletal ossicles. A. body wall tables, lateral view; B. same, ventral view; C. same, dorsal view; D. "C-shaped" bodies.

July 1967; trawl; FSBC I 24474. — 1, 180 mm; 5 October 1967; dredge; FSBC I 24475. — 2, 215, 420 mm; 25 October 1967; trawl; FSBC I 24476. — 2, 130, 150 mm; 21 November 1967; dredge; FSBC I 24477. — HOURGLASS STATION D: 1, 75 mm; 3 June 1967; dredge; FSBC I 24478. — HOURGLASS STATION J: 1, 170 mm; 6 December 1965; dredge; USNM E 22325. — 2, 170, 180 mm; 5 July 1967; dredge; FSBC I 24479. — 3, 135-170 mm; 7 August 1967; trawl; FSBC I 24480. — 7, 105-180 mm; 11 October 1967; trawl; FSBC I 24481. — 1, 150 mm; 14 November 1967; dredge; FSBC I 24483. — 2, 160, 175 mm; 14 November 1967; trawl; FSBC I 24482. — HOURGLASS STATION K: 1, 155 mm; 15 May 1967; dredge; FSBC I 24484. — HOURGLASS STATION L: 1, 220 mm; 7 June 1967; dredge; IRCZM 71:145. — 1, 160 mm; 15 November 1967; trawl; FSBC I 24485. — SHRIMP DISCARD: 1, 130 mm; 8 November 1977; double 20 ft shrimp trawl; 29°49′N, 84°39′W; 5.4 m; FSBC I 24486. — 1, 200 mm; 29 April-2 May 1978; double 55 ft four-seam balloon trawl; 26°43′N, 82°19′W to 26°46′N, 82°25′W; 8.5-12.1 m; FSBC I 24487.

Diagnosis: Large form, up to 450 mm. Body wall extremely thick, with distinct, low warts dorsally and laterally. Dorsal and ventral surface sharply defined by lateral rim of conspicuous papillae. Ventral surface flat, covered with numerous, cylindrical tube feet crowded into three rows. Ossicles include tables and C-shaped bodies. Color in life variable, usually a hue of tan or brown with darker warts and lighter ventral side.

Ossicles: Body wall — Numerous small, regular tables, 40-60 μm diameter, 25-45 μm high; margin of disc with complete circle of 10-12 perforations; spire composed of 4 pillars terminating in several teeth surrounding large central perforation; scattered C-shaped bodies of variable size, 50-70 μm long.

Type-specimen: Museum of Comparative Zoology, Harvard University, Cambridge, Mass., MCZ 509 (Syntype).

Type-locality: Florida; no locality data.

Distribution: Ranges from Bermuda, the Bahamas, South Carolina, Florida, the Gulf of Mexico, and throughout the Caribbean to off Brazil (Figure 43). Pawson (1978) reported this species from Ascension Island. Cherbonnier (1975) confirmed the presence of *I. badionotus* in the eastern Atlantic, describing material from the island of São Tomé, Gulf of Guinea. Hourglass specimens were collected at Stations B, C, D, J, K, and L (Table 9). Bathymetric range 0-55 m. Although the majority of specimens taken have been found in less than 3 m, numerous specimens were collected during the Hourglass Cruises between 18 and 55 m. Depth preference for *I. badionotus* off west-central Florida appears to be approximately 18 meters as 39 of the 54 specimens collected were taken at that depth.

TABLE 9. NUMBERS OF *Isostichopus badionotus* COLLECTED DURING PROJECT HOURGLASS, BY STATION AND MONTH.

Isostichopus badionotus																													
STA	1965					1966													1967										TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A																															
B_1	2	3															1					1				3		1	2		13
B_2	1																		1					1	1	3	1			2	10
C_1																									1				1		4
C_2																								2		1			2	2	7
D_1																									1						1
D_2																															
E																															
I																															
J					1																					2	3		7	3	16
K																								1							1
L																									1					1	2
M																															
TOT	3	5			1												1		1			1		4	4	8	4	1	12	8	54

Subscripts 1, 2 and sp designate regular, post and supplementary cruises.

Bottom type: Throughout its range, *I. badionotus* prefers grassy flats or sandy, mud bottoms. Hourglass specimens were taken predominantly from bottoms of calcareous sediment overlain by a layer of silt. Quartz sand was also noted at the shallow Stations B and J.

Diet: Several authors have studied the feeding behavior of *I. badionotus*. Crozier (1918) calculated that 500-1000 tons of sediment were ingested annually by a population of *I. badionotus* [=*Stichopus moebii* Semper, 1868] in Harrington Sound, Bermuda. Crozier estimated that each specimen would have to completely fill its gut twice daily to accomplish this. Sloan and von Bodungen (1980) found that *I. badionotus* is a non-selective feeder capable of existing on several sediment types (i.e., rock, sand, mud) within stable, sheltered habitats. Sloan and von Bodungen also noted that as a deposit feeder, passing large quantities of sediment, *I. badionotus* frequently ingests its own potentially enriched feces.

Examination of gut contents from Hourglass specimens revealed varying percentages of quartz sand and biogenic calcareous remains, depending on sediment composition of the collection site. No organic material was evident.

Symbiotic associations: Smith and Tyler (1969) reported a commensal relationship between *I. badionotus* and the pearlfish, *Carapus bermudensis* (Jones), previously thought to be host-specific for the holothurian *Actinopyga agassizii* (Selenka). Smith and Tyler found that *I. badionotus* replaces *A. agassizii* as host in deeper waters. No pearlfish were found associated with specimens examined during this study.

Additionally, the parasitic gastropod, *Balcis* sp., occurs near the mouth and on the dorsal surface embedded in the body wall (Tikasingh, 1963). Recently, it was discovered that during certain times of the year, some *I. badionotus* from Hobe Sound, Florida, harbor a commensal "bumble-bee" shrimp, *Gnathophyllum americanum* Guerin-Meneville, which apparently feeds on mucus produced by the host (JEM, personal observation).

Seasonality: As evident from Table 9, populations of *I. badionotus* within the Hourglass cruise track are transient. During the late summer of 1965, several specimens were collected at Stations B and C. However, during the following year, only one specimen was taken from the entire cruise area. In 1967, 44 specimens (81% of the total number taken during Project Hourglass) were collected. Heaviest concentrations for that year were noted from late spring to early fall. No juvenile specimens were collected.

Gear selectivity: Thirty-two Hourglass specimens were captured with the trawl, 22 with the dredge.

Remarks: *Isostichopus badionotus*, commonly referred to as sea pudding, is the most color-variable holothurian species in the Western Atlantic. Hues of orange, yellow, brown or purple are not uncommon. Frequently, the warts on the dorsal surface are darker than the surrounding body wall tissue, giving the animal a "chocolate chip" appearance. Young specimens, less than 1 cm, lack body wall pigment and live a cryptic existence beneath rocks or within reef structures.

Quantitatively, *I. badionotus* represented 25% of the total number of holothurians taken during Project Hourglass.

Family Holothuriidae Ludwig, 1894

Diagnosis: Gonad in single tuft on left side of dorsal mesentery; tentacle ampullae present.

Holothuria (*Semperothuria*) *surinamensis* Ludwig, 1875

Figures 46, 47

Holothuria surinamensis Ludwig, 1875, p. 35, fig. 27; Crozier, 1914, p. 233; 1917, p. 561; Deichmann, 1926, p. 12, pl. 1, figs. 1 a-g; 1930, p. 63, pl. 3, figs. 12-15, 19; H. L. Clark, 1933, p. 105; Deichmann, 1939, p. 131; Engel, 1939, p. 11; A. H. Clark, 1939, p. 455; Reed, 1941, p. 41; H. L. Clark, 1942, p. 385; Deichmann, 1954, p. 393; Domantay, 1959, p. 188; Harry, 1979, p. 40.

Holothuria (*Holothuria*) *surinamensis*: Panning, 1934, p. 42, fig. 34.

Halodeima surinamensis: Cherbonnier, 1951, p. 19, pl. 3, figs. 10-22.

Semperothuria surinamensis: Deichmann, 1958, p. 303; Tikasingh, 1963, p. 91, figs. 44-46; Deichmann, 1963, p. 109; Tommasi, 1969, p. 6, fig. 3; Martínez de Rodríguez, 1973, p. 45, pl. 1, figs. 1, 2, pl. 3.

Holothuria (*Semperothuria*) *surinamensis*: Rowe, 1969, p. 135; Levin and Gomes, 1975, p. 60; Cayedo, 1978, p. 179, pl. 11, figs. 1-5, pl. IX, figs. a-c.

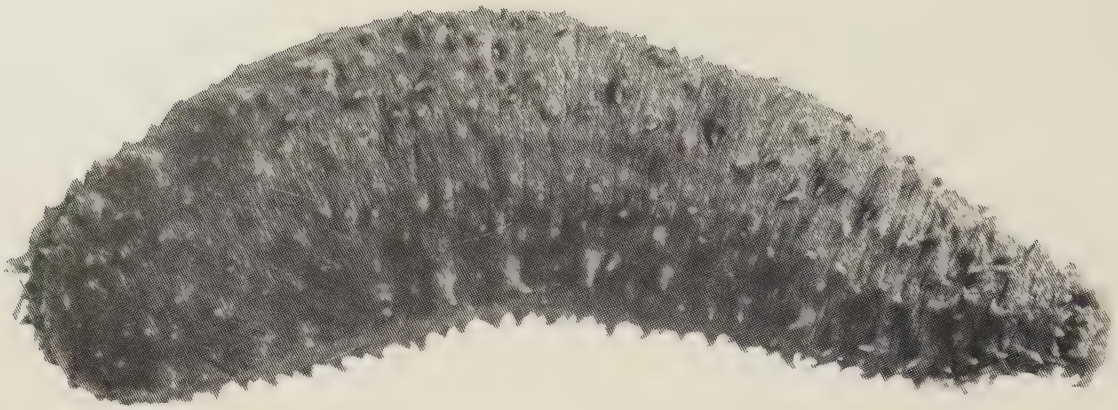

Figure 46. *Holothuria* (*Semperothuria*) *surinamensis* Ludwig, IRCZM 71:151, off La Parguera, Puerto Rico, 68 mm TL, dorsal view.

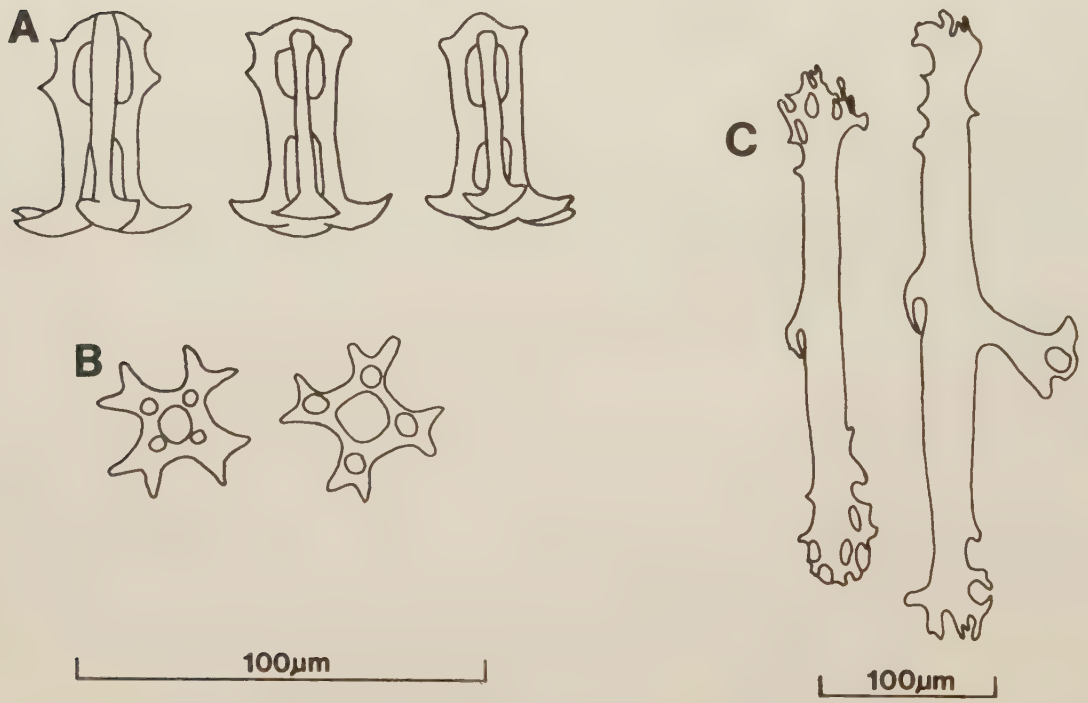

Figure 47. *Holothuria* (*Semperothuris*) *surinamensis* Ludwig, skeletal ossicles. A. body wall tables, lateral view; B. same, ventral view of disk; C. rods from body wall.

Material examined: HOURGLASS STATION B: 1, 82 mm; 14 March 1967; trawl; FSBC I 24418.

Diagnosis: Large, burrowing form, up to 200 mm. Body cylindrical. Podia few, scattered, papillate dorsally, cylindrical ventrally. Cuvierian organ absent. Ossicles consisting of tables and rods, no buttons. Coloration in life light yellow to dark brown.

Ossicles: Body wall — Uniform tables; disc 35-40 μm diameter, spire 45-60 μm high; disc reduced, cross-shaped, with 9-15 marginal teeth, 1 large central perforation; spire high, composed of 4 slender pillars, terminating in 12 small teeth forming Maltese cross; large, flat rods with perforate or dentate margin beneath tables; tables of juveniles have well-developed disc with complete ring of marginal holes (Deichmann, 1926).

Type-specimen: Würzberg Museum, West Germany, according to Deichmann (1954).

Type-locality: Surinam.

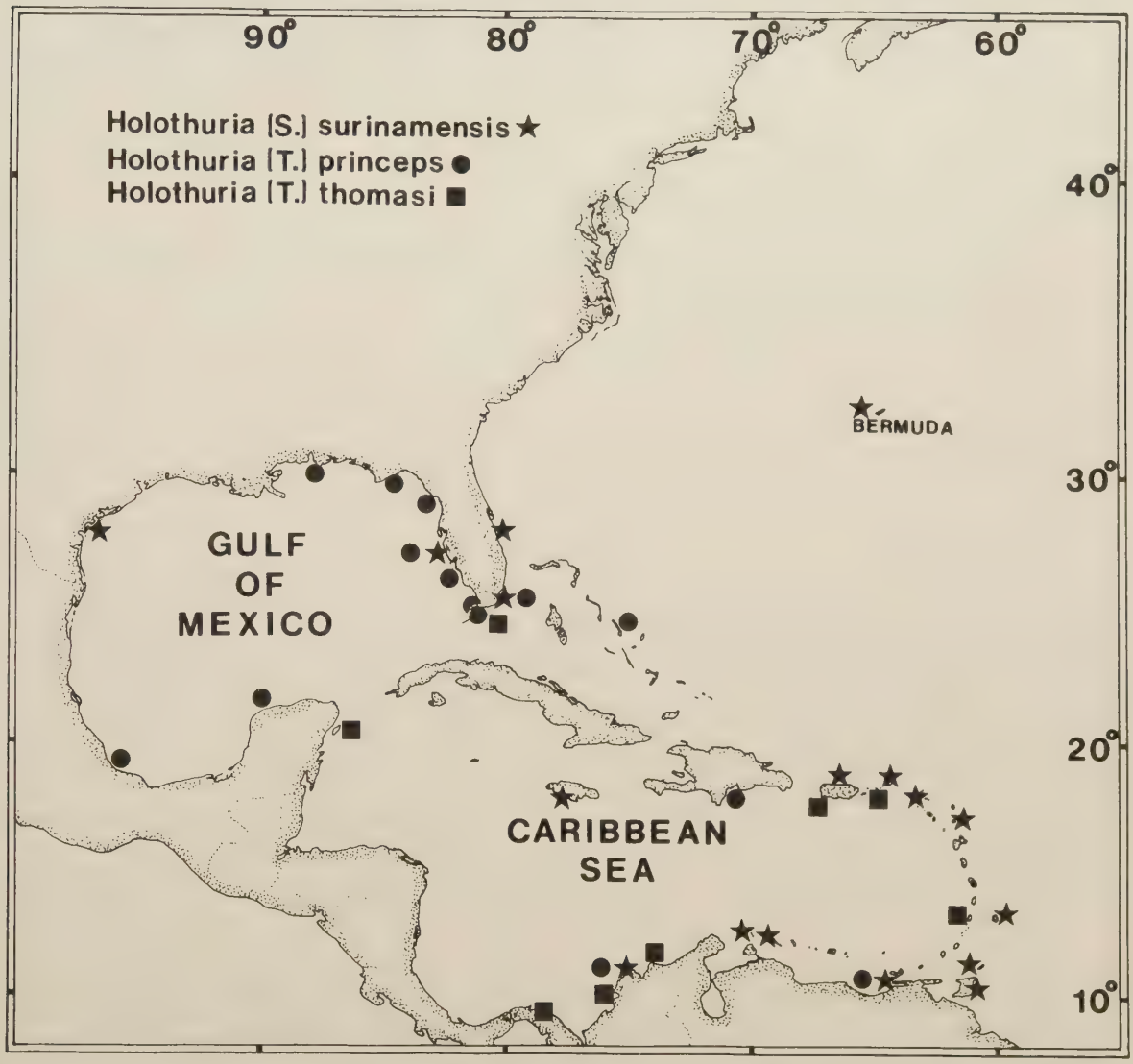

Figure 48. Geographic distributions of *Holothuria* (*Semperothuria*) *surinamensis*, *Holothuria* (*Theelothuria*) *princeps*, and *Holothuria* (*Thymiosycia*) *thomasi* in the northwestern Atlantic and the Gulf of Mexico.

Distribution: Known to occur at Bermuda, off the Florida east coast, throughout the Caribbean, Surinam and off Brazil (Figure 48). In the Gulf of Mexico, previously reported only from the Texas coast (Reed, 1941). The Hourglass specimen collected at Station B represents the first record of this species from the eastern Gulf. Bathymetric range 0-42 m.

Bottom type: Throughout its range, *H. surinamensis* is associated with a variety of substrates including corals, flat rocks, coralline algae and eel-grass (H. L. Clark, 1933; Deichmann, 1954). Crozier (1914) found numerous specimens of this species in Bermuda buried in mud around the roots of *Penicillus* and mangroves. Caycedo (1978) noted juveniles among the branches of the stony coral, *Porites*. Hourglass Station B was characterized by limestone outcroppings flanked by smooth areas of shell and quartz sand frequently covered with *Caulerpa* and *Halophila*.

Diet: Gut analysis revealed 50% amorphous material, 25% quartz sand and 25% biogenic calcareous remains composed of forams, echinoid plates, echinoid spines and molluscan fragments. Miscellaneous items included a few sponge spicules, fecal castings from other invertebrates and a small hydroid fragment.

Reproduction: This species is known to frequently reproduce asexually by transverse fission (Crozier, 1917).

Symbiotic associations: Deichmann (1926), working at Antigua, recovered two specimens of *Carapus* (=*Fierasfer*) from the cloaca of this species.

Behavior: Crozier (1914) published an extensive account of the sensory reactions of *H. surinamensis* to mechanical, chemical and photic stimuli.

Remarks: The occurrence of *H. surinamensis* in the Gulf of Mexico is apparently rare.

Holothuria (*Theelothuria*) *princeps* Selenka, 1867

Figures 49, 50

Holothuria princeps Selenka, 1867, p. 332, pl. 18, figs. 67-69; Deichmann, 1930, p. 58, pl. 2, figs. 1-8; H. L. Clark, 1933, p. 101; Deichmann, 1939, p. 130; Cherbonnier, 1949a, p. 160, pl. 1, figs. 1-22; Deichmann, 1954, p. 393; Caso, 1955, p. 517, pls. 6, 7; Deichmann, 1957, p. 8, figs. 16-20; Caso, 1961, p. 349, pl. 14; Menzel, 1971, p. 87; Tommasi, 1972, p. 17.

Holothuria imperator Deichmann, 1930, p. 62, pl. 3, figs. 1-11.

Holothuria (*Holothuria*) *princeps*: Panning, 1935, p. 101, fig. 94.

Theelothuria princeps: Deichmann, 1958, p. 285; Wells and Wells, 1961, p. 268; Dawson, 1971, p. 730; Haburay et al., 1974, p. 105; Martínez de Rodríguez and Herminson, 1975, p. 193, pl. 4.

Holothuria (*Theelothuria*) *princeps*: Rowe, 1969, p. 157; Caycedo, 1978, p. 170, pl. 7, figs. 1-13.

Material examined: HOURGLASS STATION A: 1, 80 mm; 3 January 1966; dredge; IRCZM 71:146. — HOURGLASS STATION B: 1, 74 mm; 4 October 1965; dredge; USNM E 22324. — 1, 30 mm; 2 November 1967; dredge; FSBC I 24488. — HOURGLASS STATION J: 1, 76 mm; 11 October 1967; dredge; FSBC I 24489. — HOURGLASS STATION K: 1, dried; 15 May 1967; trawl; FSBC I 29187. — 1, 117 mm; 14 November 1967; trawl; FSBC I 24490. — HOURGLASS STATION M: 1, 56 mm; 6 July 1967; dredge; FSBC I 24362. — FEDERAL CLAM: 2, 40, 44 mm; 11 November 1969; hydraulic dredge; 29°15′N, 83°12′W; 1.5-3.0 m; FSBC I 24491. — 2, 45, 50 mm; 5 December 1969; hydraulic dredge; 29°14′N, 83°11′W; 0.6-2.1 m; FSBC I 24361. — 2, 135, 137 mm; 18 July 1971; hydraulic dredge; 26°36.0′N, 82°14.3′W; 3.1 m; FSBC I 24492. — 1, 30 mm; 19 July 1971; box dredge; 26°51.4′N, 82°28.3′W; 13.7 m; FSBC I 24493. — 1, 57 mm; 3 September 1971; hydraulic dredge; 25°23.5′N, 81°36.4′W; 9.2 m; FSBC I 24494. — 2, 87, 90 mm; 6 September 1971; hydraulic

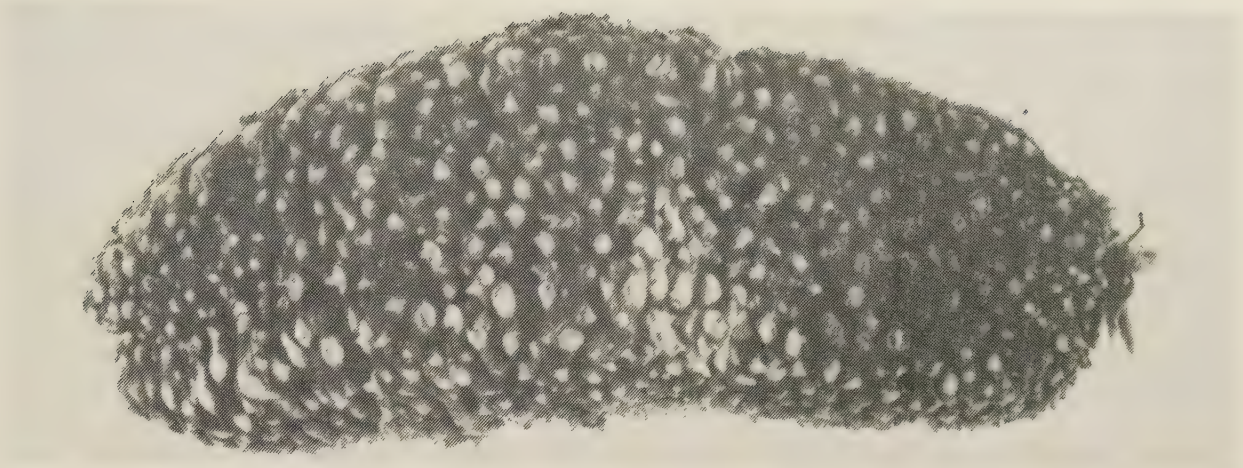

Figure 49. *Holothuria* (*Theelothuria*) *princeps* Selenka, FSBC I 25008, off Palm Beach, Florida, 110 mm TL, dorsal view.

dredge; 24°40.6′N, 81°47.8′W; 10.7 m; FSBC I 24495. — SHRIMP DISCARD: 1, 98 mm; 7-10 July 1978; double 65 ft shrimp trawl; 26°43′N, 82°19′W to 26°46′N, 82°24′W; 10.3-13.7 m; FSBC I 24496.

Diagnosis: Large, cylindrical form, up to 300 mm. Body wall thick, strongly contracted in preserved specimens. Podia numerous, scattered over entire body, dorsally as papillae, ventrally as cylindrical tube feet. Ossicles abundant, consisting of tables and knobbed buttons. Curvierian organs absent. Coloration in life brown and white, with light ring around base of most dorsal papillae.

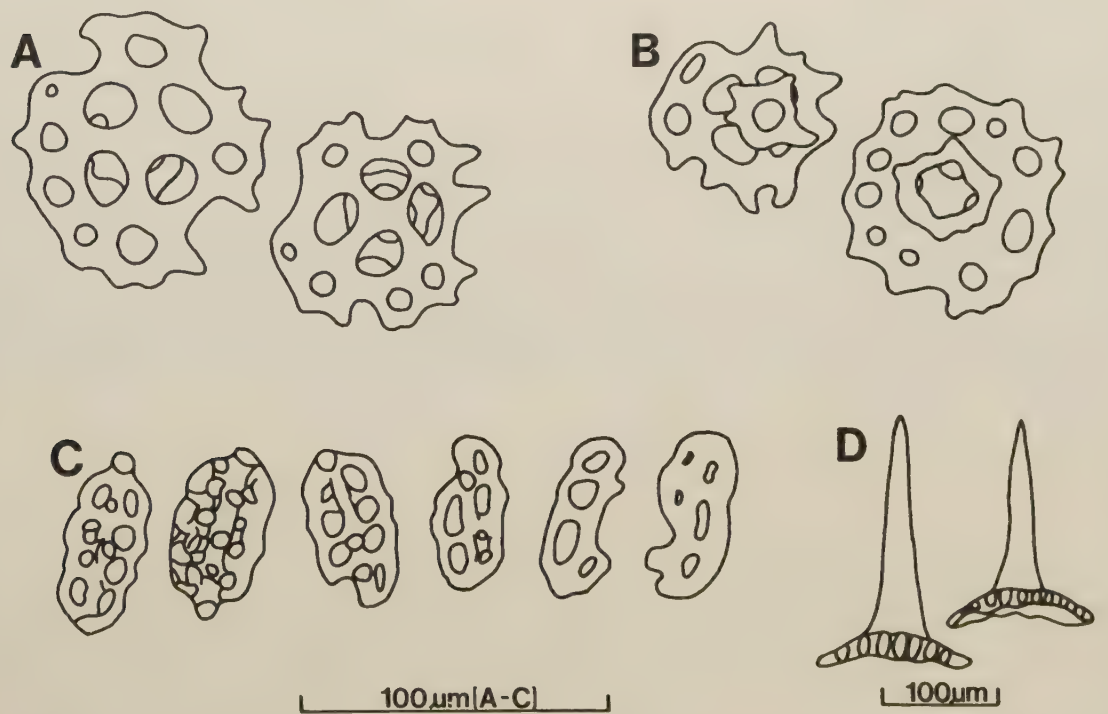

Figure 50. *Holothuria* (*Theelothuria*) *princeps* Selenka, skeletal ossicles. A. body wall tables, ventral view; B. same, dorsal view; C. buttons from body wall; D. large "tack-like" tables from podia (smaller scale line for D only).

Ossicles: Body wall — Irregular tables, with undulate to dentate margin; disc 45-65 μm diameter, with 4 large central perforations and variable number of smaller marginal perforations; spire short, terminating in few to several short teeth; body wall tables of juveniles have fragile disc with high spire, either solid or with crossbars; numerous irregular buttons, 40-80 μm wide, frequently twisted, incomplete, with surface often knobbed on midline and occasionally near margin. Podia — Large, characteristic, "tack-like" tables with enormous spire, 100-200 μm diameter, 150-300 μm high, occasionally absent in larger specimens; numerous supporting rods with many large perforations; well-developed end plate.

Type-specimen: Museum of Comparative Zoology, Harvard University, Cambridge, Mass., MCZ 685, 686 (syntypes).

Type-locality: Pensacola, Florida (MCZ 685); Charlotte Harbor, Florida (MCZ 686).

Distribution: Occurs in the Bahamas and along the southern, western and northern coasts of Florida. Also reported from Veracruz and Yucatan, Mexico, Dominican Republic and off the coasts of Colombia and Venezuela (Figure 48). Hourglass specimens were taken at Stations A, B, J, K, and M (Table 10). Bathymetric range 0-54 m; one specimen was presumably taken at Hourglass Station M (73 m), but collection data is questionable.

Bottom type: Caycedo (1978) found *H. princeps* off Colombia on a grassflat of *Syringodium filiforme*. Haburay et al. (1974) found *H. princeps* buried in sand, 100-200 m offshore in the northeast Gulf. Specimens collected during the Federal Clam and Shrimp Discard projects were usually taken from sand, mud or shell bottoms. Hourglass specimens were collected from sediments composed of quartz sand and shell hash (Stations A, B, and J) or dead bryozoans, crushed shell and calcareous algae particles (Stations K and M).

Diet: Gut analysis of specimens from Stations B and J revealed 60-70% quartz sand, 30% calcareous remains including bivalves, pteropods, scaphopods, ostracods, forams, and echinoid spines, and 5-10% amorphous material. Also noted were a few sponge spicules and fish scales.

Symbiotic associations: Wells and Wells (1961) described a new species of pinnotherid crab, *Pinnaxodes floridensis*, occurring as a commensal within the cloaca and respiratory trees of *H.*

TABLE 10. NUMBERS OF *Holothuria (Theelothuria) princeps* COLLECTED DURING PROJECT HOURGLASS, BY STATION AND MONTH.

Holothuria (Theelothuria) princeps																													
STA	1965					1966													1967										TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A						1																								1
B_1			1																										1	2
B_2																														
C_1																														
C_2																														
D_1																														
D_2																														
E																														
I																														
J																													1	1	2
K																								1							1
L																															
M																										1					1
TOT			1			1																		1		1			1	2	7

Subscripts 1, 2 and sp designate regular, post and supplementary cruises.

princeps. Although male-female pairs were frequently encountered, most hosts harbored a single specimen, with infestation rates ranging from 45-61%.

Dawson (1971) was the first to report a relationship between *H. princeps* and the pearlfish, *Carapus bermudensis*, a known inquiline of several holothurian species. Haburay et al. (1974) recorded both *P. floridensis* and *C. bermudensis* from a single host specimen of *H. princeps*.

None of these relationships were noted for specimens examined during this study.

Holothuria (*Thymiosycia*) *thomasi* Pawson and Caycedo, 1980

Figures 51, 52

Holothuria (*Thymiosycia*) *thomasi* Pawson and Caycedo, 1980, p. 454, figs. 1, 2.

Material examined: HOURGLASS MATERIAL: None. — FEDERAL CLAM: 1 juv., 48 mm; 30 May 1971; box dredge; 24°54.1'N, 80°36.1'W; 3.9 m; FSBC I 24509.

Figure 51. *Holothuria* (*Thymiosycia*) *thomasi* Pawson and Caycedo, off Bahia Granate, Colombia, 700 mm TL (after Pawson and Caycedo, 1980).

Diagnosis: Large, reef-dwelling form, up to 2 m. Body cylindrical, elongate. Dorsal surface with scattered papillate podia; more numerous podia of cylindrical form ventrally. Tentacles surrounded by conspicuous collar of papillae. Ossicles consisting of tables and smooth buttons. Cuvierian organs present. Coloration in life yellowish brown to maroon with mottling.

Ossicles: Body wall — Well-developed, variable tables; disc squarish in outline, with 4 large, central perforations and usually a ring of 12 smaller, marginal perforations; spire short, composed of 4

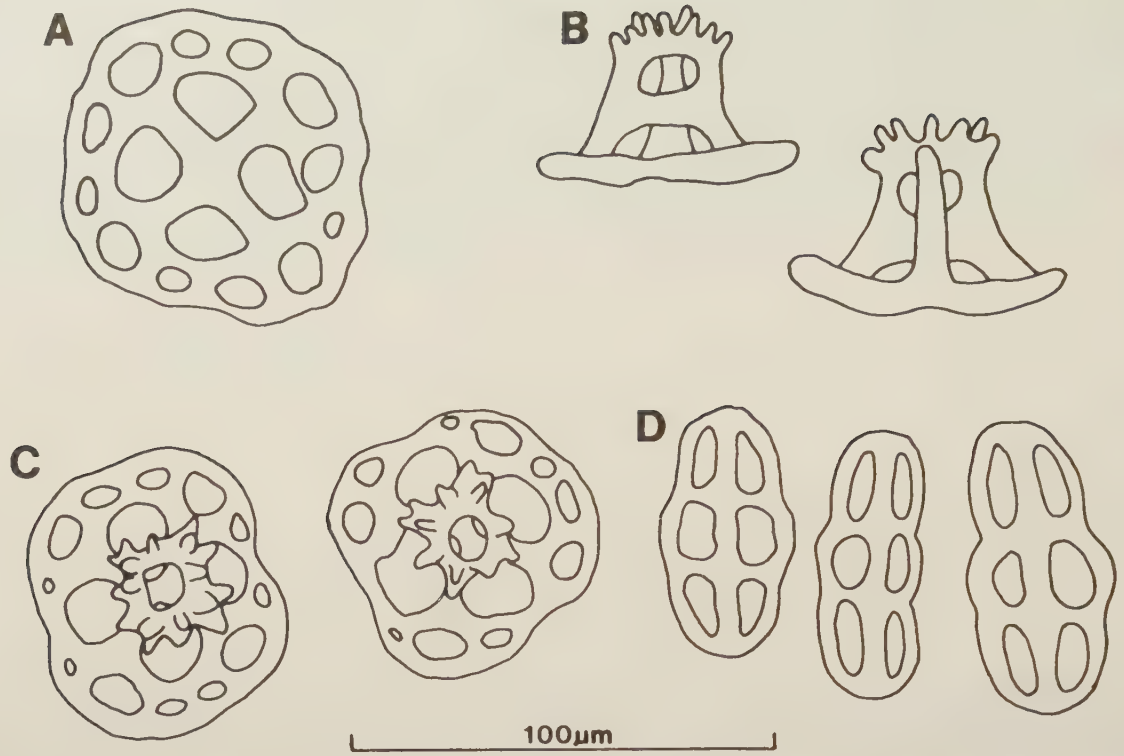

Figure 52. *Holothuria* (*Thymiosycia*) *thomasi* Pawson and Caycedo, skeletal ossicles. A. body wall table, ventral view; B. same, lateral view; C. same, dorsal view; D. buttons from body wall.

pillars, terminating in several short, blunt teeth surrounding large perforation; tables 50-70 µm diameter, 40-50 µm height; numerous elongate, smooth buttons 50-70 µm long, 25-35 µm wide, with 3 pairs of oblong perforations. Podia — Tables, buttons and few perforated plates; well-developed end plate.

Type-specimen: National Museum of Natural History, Smithsonian Institution, USNM E 18081.

Type-locality: Alligator Reef, Florida Keys, Florida.

Distribution: Ranges from the Florida Keys, Puerto Rico, Virgin Islands, Lesser Antilles, Colombia, Panama and eastern Yucatan, Mexico; 3-30 m (Figure 48).

Bottom type: The preferred habitat for *H. thomasi* is coral reef (Pawson and Caycedo, 1980). The specimen examined in this study was collected 4.8 km north of the type-locality on a rock bottom.

Diet: Pawson and Caycedo (1980) found that this species appears to "vacuum" the sediment, ingesting large quantities of calcareous sand and rubble. Specimens from St. Croix, Virgin Islands, and Panama were noted to feed only during the evening, while others from Colombia were found to be active during daylight hours.

Remarks: The apparent juvenile of 48 mm TL reported herein is by far the smallest known specimen of this species. The type-series (Pawson and Caycedo, 1980) comprised strongly contracted specimens at least 15 cm long. In the present specimen, the anterior notches in radial pieces of the calcareous ring are narrow, not wide, thereby approaching the condition in specimens of the Indo-

Pacific species *H. hilla* Lesson. Although table diameters average 66 μm in both species, the ossicles of this small specimen of *H. thomasi* differ from those of *H. hilla* at a comparable body size as follows: in *H. hilla*, 60% (n = 50) of tables have 11, 12 or 13 perforations, whereas in *H. thomasi* 65% (n = 50) have 10 or 11 perforations. In *H. hilla*, buttons average 80 μm in length, and only 26% (n = 50) have 6 perforations (32% have 7, and 20% have 8), whereas in *H. thomasi*, buttons average 66 μm in length, and 86% (n = 50) have 6 perforations (9% have 5; 4% have 7). It is evident that *H. hilla* and *H. thomasi* are closely related. Study of the larger growth series is necessary for a conclusive clarification of their relationship.

ORDER ELASIPODIDA THÉEL, 1882

Diagnosis: Introvert and retractor muscles absent. Tube feet and respiratory trees well developed. Tentacles 10-30, shield-shaped. Body with conspicuous external bilateral symmetry. Mesentery of posterior loop of intestine attached to right dorsal interradius. Ossicles lacking or composed of pointed rods, wheels or cruciform bodies; no tables.

Remarks: Four species of the order Elasipodida are known to occur in the Gulf of Mexico (Table 2), all at depths greater than those sampled during Project Hourglass.

KEY TO ELASIPODIDA OF THE GULF OF MEXICO

1. Midventral tube feet poorly developed or lacking; ossicles large perforated plates ..... *Deima validum validum* Théel, 1879
1. Midventral tube feet well developed; ossicles rods or crosses 2
2. Anus ventral; circumoral papillae absent ..... *Psychropotes depressa* (Théel, 1882)
2. Anus dorsal; circumoral papillae present 3
3. Ossicles large crosses ..... *Benthodytes lingua* Perrier, 1896
3. Ossicles scattered rods ..... *Benthodytes typica* Théel, 1882

ORDER MOLPADIIDA HAECKEL, 1896

Diagnosis: Introvert and retractor muscles absent. Tube feet absent or markedly reduced. Tentacles simple. Body stout, tapering posteriorly to form more or less conspicuous tail. Anal papillae and respiratory trees present. Ossicles include tables, anchors, fusiform rods or perforated plates; phosphatic bodies often present.

Remarks: Four species of the order Molpadiida are known to occur in the Gulf of Mexico (Table 2). Although no molpadiids were taken during Project Hourglass, one species was collected during the Federal Clam Project.

KEY TO MOLPADIIDA OF THE GULF OF MEXICO

1. Tentacles with 2 pairs of digits; terminal digit lacking; ossicles small crossed baskets ..... *Paracaudina chilensis obesacauda* (H. L. Clark, 1907)

1. Tentacles with 1-3 pairs of digits and 1 terminal digit; ossicles include tables 2
2. Ossicles single-pillared tables with solid spire ..... *Molpadia musculus* (Risso, 1826)
2. Ossicles 3-pillared tables with spire composed of several crossbeams 3
3. Phosphatic bodies present ..... *Molpadia cubana* Deichmann, 1940
3. Phosphatic bodies absent ..... *Molpadia barbouri* Deichmann, 1940

Family Caudinidae Heding, 1931

Diagnosis: Tentacles with 2 pairs of digits, lacking terminal digit; tentacle ampullae present. Ossicles include tables, plates, crossed baskets or irregular deposits; phosphatic bodies absent.

Paracaudina chilensis obesacauda (H. L. Clark, 1907)

Figures 53, 54

Caudina obesacauda H. L. Clark, 1907, p. 38, pl. 9, figs. 1-5; Deichmann, 1930, p. 201, pl. 24, figs. 6-8; H. L. Clark, 1933, p. 117.

Pseudocaudina obescauda: Heding, 1931, p. 283.

Paracaudina obesacauda: Heding, 1932, p. 455; Deichmann, 1940, p. 215; 1954, p. 406.

Paracaudina chilensis var. *obesacauda*: H. L. Clark, 1935, p. 284.

Figure 53. *Paracaudina chilensis obesacauda* (Clark), IRCZM 71:109, off Jupiter Inlet, Florida, 108 mm TL, lateral view.

Material examined: HOURGLASS MATERIAL: None. — FEDERAL CLAM: 1, 100 mm; 22 May 1970; hydraulic dredge; 29°09.6′N, 83°09.8′W; 4.8 m; IRCZM 71:149. — 1, 103 mm; 22 May

1971; hydraulic dredge; 25°45.4′N, 81°44.1′W; 7.6 m; FSBC I 24516. — 1, 39 mm; 14 July 1971; hydraulic dredge; 26°44.8′N, 82°06.7′W; 3.7 m; FSBC I 24517. — 2, 71, 98 mm; 23 August 1971; hydraulic dredge; 25°43.9′N, 81°42.2′W; 6.1 m; USNM E 22339.

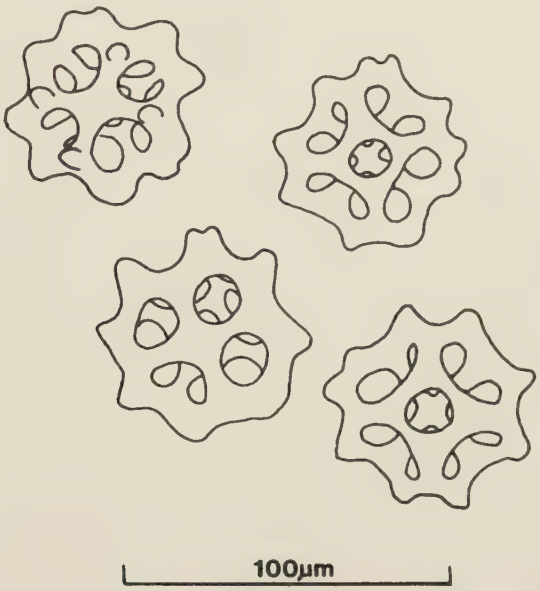

Figure 54. *Paracaudina chilensis obesacauda* (Clark), skeletal ossicles, crossed baskets from body wall.

Diagnosis: Medium-size, burrowing form, up to 150 mm. Body barrel-shaped, with distinct, tapering tail. Podia absent. Integument containing ossicles of one type, crossed baskets. Coloration in life white to grey.

Ossicles: Numerous crossed-baskets, 45-65 µm diameter; cross perforate on one side, solid opposite.

Type-specimen: Unknown.

Type-locality: Marco, Florida.

Distribution: Previously thought to occur only in the Gulf of Mexico from the Dry Tortugas to Galveston, Texas (Deichmann, 1954) (Figure 55). We have examined specimens dredged off Tequesta, Florida east coast, during the deepening of Jupiter Inlet. Although no specimens were taken during Project Hourglass, five specimens were collected during the Federal Clam Project. Bathymetric range 0-10 m.

Diet: Gut analysis revealed 70% quartz sand and 30% calcareous remains including ostracods, molluscan fragments, echinoid spines and foram tests.

Remarks: *Paracaudina chilensis sensu lato* has had a complex history (see summaries by H. L. Clark, 1935, and Pawson, 1963). Earlier concepts of several species of *Paracaudina* occurring in Japan, Australia, New Zealand, California, and Chile have tended to be discarded in favor of a concept of a polytypic species, *P. chilensis*, that is widely distributed in the Indo-Pacific. The species *P. obesacauda* (H. L. Clark, 1907), from Florida and the Gulf of Mexico, was regarded later by Clark (1935) as a "variety" of *chilensis*. According to the provisions of the International Code of Zoological Nomenclature, Clark's "variety" has no status in nomenclature.

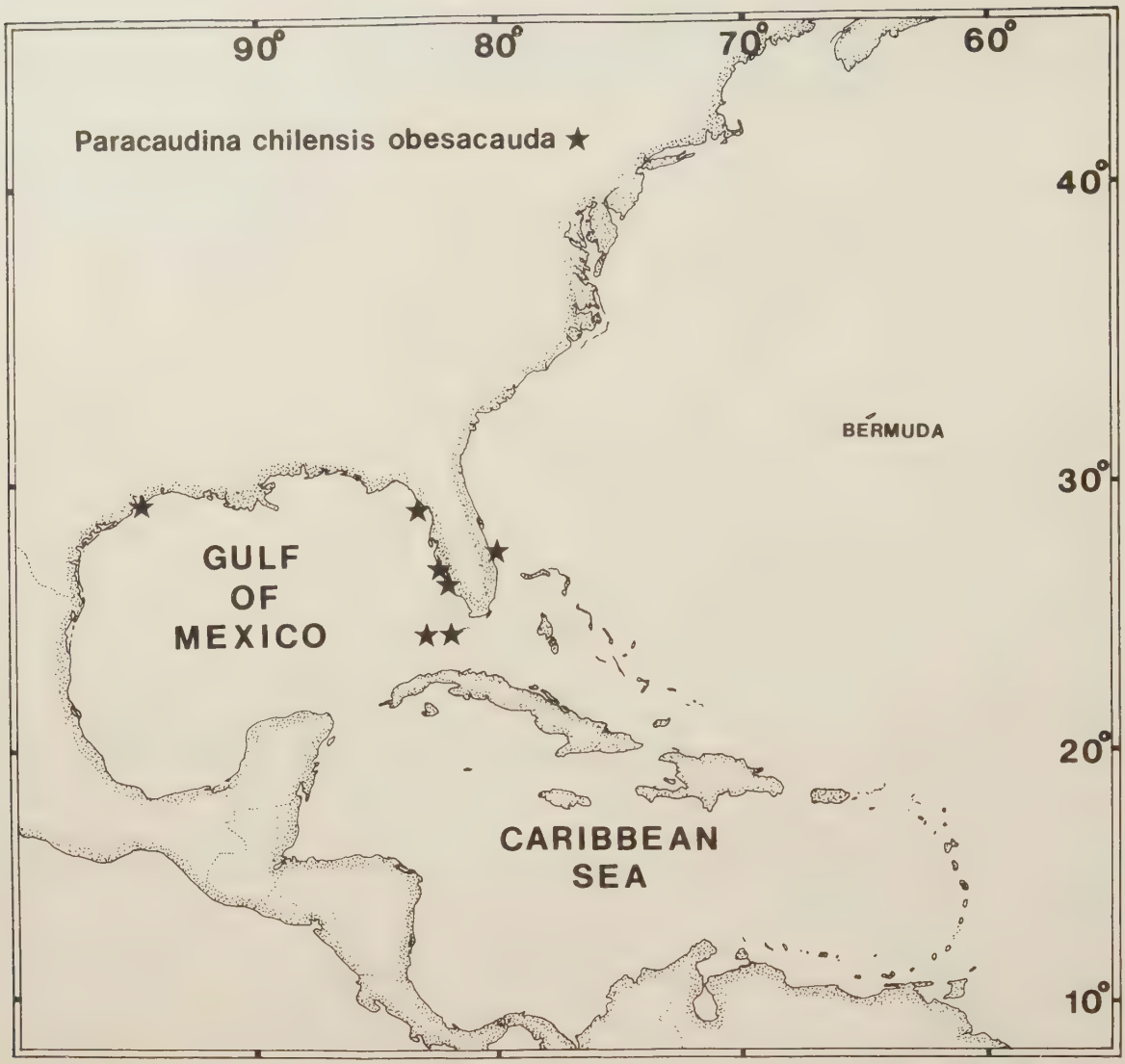

Figure 55. Geographic distribution of *Paracaudina chilensis obesacauda* in the northwestern Atlantic and the Gulf of Mexico.

The Florida and Gulf of Mexico *Paracaudina obesacauda* closely resembles the Indo-Pacific species, although its ossicles are slightly smaller. In the absence of extensive collections for comparative purposes, we have considered it wisest to retain *P. obesacauda* as a subspecies, geographically isolated from the Indo-Pacific nominate subspecies *P. c. chilensis*. It is not difficult, however, to envision *P. chilensis* entering the Caribbean area when the Panamanian Isthmus was below sea level, 1-5 million years ago. Perhaps retention of *P. c. obesacauda* is an unnecessarily conservative step; study of larger collections should solve the problem.

ORDER APODIDA BRANDT, 1835

Diagnosis: Introvert and retractor muscles absent. Tube feet absent or markedly reduced. Tentacles simple. Body vermiform, with smooth, rough or warty texture. Anal papillae, respiratory trees and tentacle ampullae absent. Ossicles include anchors and anchor plates or wheels, occasionally lacking altogether.

Remarks: Seven species of the order Apodida are currently known to occur in the Gulf of Mexico (Table 2), but none were collected during Project Hourglass.

KEY TO APODIDA OF THE GULF OF MEXICO

1. Ossicles wheels with six spokes ..... *Chiridota rotifera* (Poutalès, 1851)
1. Ossicles anchors and anchor plates 2
2. Arms of anchors smooth, knobs present at vertex 3
2. Arms of at least some anchors serrate, knobs absent at vertex 4
3. Small form, less than 10 cm; stock of anchors unbranched ..... *Synaptula hydriformis* (Lesueur, 1824)
3. Large form, up to 100 cm; stock of anchors branched .... *Euapta lappa* (J. Müller, 1850)
4. Anchors and anchor plates less than 200 μm long ..... *Leptosynapta crassipatina* H. L. Clark, 1924
4. At least some anchors or anchor plates greater than 300 μm long 5
5. Anchors and anchor plates varying greatly in size between anterior and posterior regions ..... *Leptosynapta multigranula* H. L. Clark, 1924
5. Anchors and anchor plates similar in size throughout 6
6. Stock of anchors branched ..... *Protankyra brychia* (Verrill, 1885)
6. Stock of anchors not branched ..... *Protankyra benedeni* (Ludwig, 1881)

DISCUSSION

With the possible exclusion of several deep-water forms, the composition of the holothurian fauna of the Gulf of Mexico (Table 2) is approximately what one might expect to find, based upon a knowledge of the western Atlantic holothurians, as embodied in Deichmann (1930). At least 66% of the known western Atlantic species are found in the Gulf and continued collection efforts will undoubtedly add others to the list. Relations of the Gulf fauna lie mainly with nearby areas of the Caribbean Sea. There is only a single so-called "endemic" species, *Allothyone mexicana* (Deichmann). A recently described species, *Thyone adinopoda* Pawson and Miller may also prove to be endemic as this species is currently known only from the northern Gulf. It is likely, however, that both of these species may occur elsewhere in the Caribbean.

HOURGLASS HOLOTHURIANS

Although a relatively small percentage of the existing Gulf species are represented in Hourglass collections, certain faunal relationships are evident from the data. Of the 16 Hourglass species (Table 11), only three, *Thyonella gemmata*, *T. pervicax* and *Ocnus pygmaeus*, are common components of the warm-temperature Carolinian fauna north of east-central Florida. The remaining species share their affinities with tropical holothurians from the Caribbean and the West Indies. Influenced by the

TABLE 11. DISTRIBUTION OF HOURGLASS HOLOTHURIANS BY STATION AND DEPTH.*

Depth (m)	6		18		37		55		73	
Hourglass Station	A	I	B	J	C	K	D	L	E	M
Phyllophorus (Urodemella) occidentalis	1									
Thyone crassidisca		5								
Thyonella gemmata	1	1								
Ocnus pygmaeus	1	19	7		4					
Holothuria (Theelothuria) princeps	1		2	2		1				1**
Thyonella pervicax		1	5	7	1					
Holothuria (Semperothuria) surinamensis			1							
Thyonella sabanillaensis				1						
Isostichopus badionotus			23	16	11	1	1	2		
Thyone pawsoni	1				1					
Thyone inermis		1			2					
Pseudothyone belli	2				42	6				
Thyone pseudofusus			5		20					
Astichopus multifidus						3				
Euthyonacta solida							2			
Psolus tuberculosus									8	4
Number of species per depth:	9		7		9		2		2(1**)	
Species most abundant at depth:	4		5		4		1		1	

*Depth of greatest occurrence underlined.
**Collection data questioned.

clear, warm waters of the Loop Current, many Caribbean holothurians and other marine invertebrates (Serafy, 1979; Lyons, 1980) have become established in the eastern Gulf along the west Florida shelf. Northern geographic ranges for several tropical holothurian species extend farther in the Gulf than along the eastern seaboard. Likewise, common bathymetric ranges for many species are deeper in the eastern Gulf as tropical species display submergence in higher latitudes.

Lyons and Collard (1974) designate three distributional zones ("nearshore," "shallow shelf," "middle shelf") for the west Florida shelf in respect to depth, temperature, salinity and sediment composition. The nearshore zone (0-10 m) is characterized by quartz sand sediments, considerable temperature fluctuations and salinities of 31-34$^{O}/_{OO}$ (Lyons, 1980). The shallow shelf zone (10-30 or 40 m), overlain by green, coastal waters, is predominantly composed of quartz sand with scattered limestone outcroppings. Annual temperature fluctuations vary considerably and salinities range from 35-36$^{O}/_{OO}$ (Lyons, 1980). Within the middle shelf zone (40-140 m), sediments are mostly calcareous in origin. Limestone outcroppings are common, and the entire zone is covered with clear waters. Temperatures fluctuate minimally (20°C, ± 3°C), and the salinities remain near 35$^{O}/_{OO}$ (Lyons, 1980). An examination of these zones is useful in determining distributional patterns and relationships among Hourglass holothurians.

In Table 11, the Hourglass species are arranged according to most abundant occurrence with increasing depth. The nearshore zone component (Stations A and I, 6 m) comprises nine species, of

which four, *Phyllophorus* (*Urodemella*) *occidentalis*, *Thyone crassidisca*, *Thyonella gemmata*, and *Ocnus pygmaeus* are found most frequently at this depth. These four species are presumably hardier, more tolerant forms; three, *P.* (*U.*) *occidentalis*, *T. gemmata*, and *O. pygmaeus*, have wide-ranging distributions, and all have been found off east-central Florida within the zoogeographic transition zone between the warm-temperature Carolinian province and the tropical West Indian province.

For the holothurians, the shallow shelf zone [Stations B, J (18 m) and C, K (37 m)] was the most productive in the terms of numbers and diversity. Of the 11 species taken from the shallow shelf, all have an essentially Caribbean-West Indian distribution, although three (*Thyone pseudofusus*, *Ocnus pygmaeus* and *Thyonella pervicax*) also extend northwards off the east coast of the United States to the Cape Hatteras area (*T. pseudofusus*, *O. pygmaeus*) or to Cape Cod (*T. pervicax*). Nine species occurred most frequently at this zone, and six species were also represented within the nearshore zone. Although several species are represented by only 1-3 specimens, six species, *Holothuria* (*Theelothuria*) *princeps, Thyonella pervicax, Isostichopus badionotus, Thyone pawsoni, Pseudothyone belli,* and *Thyone pseudofusus*, totalling 152 specimens, account for 72% of the total number of holothurians collected during the Hourglass Cruises. Particularly interesting in this zone is the submergence of several species. Greatest previously reported depths for *P. belli, Astichopus multifidus,* and *I. badionotus*, 22 m, 27 m, and 27 m, respectively, were all exceeded within the shallow shelf zone. These increased depth ranges are best explained as submergence of tropical species in higher latitudes; submergence provides more stable environmental parameters, particularly temperature and salinity.

Within the middle zone [Stations D, L (55 m) and E, M (73 m)], only four species, *Holothuria* (*Theelothuria*) *princeps, Isostichopus badionotus, Euthyonacta solida,* and *Psolus tuberculosus*, were found. *Holothuria* (*T.*) *princeps* is commonly found at depths of 0-40 m, and the occurrence of this species at Station M (73 m) may be due to questionable collection data rather than a considerable increase in depth range. Occurring at Stations D and L, *I. badionotus* extends its maximum depth to 55 m, thereby adding further evidence for submergence in this species. The remaining species, *E. solida* and *P. tuberculosus*, were found exclusively in the middle zone, Station D and Stations E, M, respectively. Although little information has been published on *E. solida*, existing literature and present data suggest that this species may occupy several habitats within a wide-ranging distribution. The preferred habitat for *P. tuberculosus* is rock substratum in depths from 100-240 m. The occurrence of *P. tuberculosus* at a relatively shallow depth (73 m) is best explained by the presence of limestone outcroppings within the middle zone.

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